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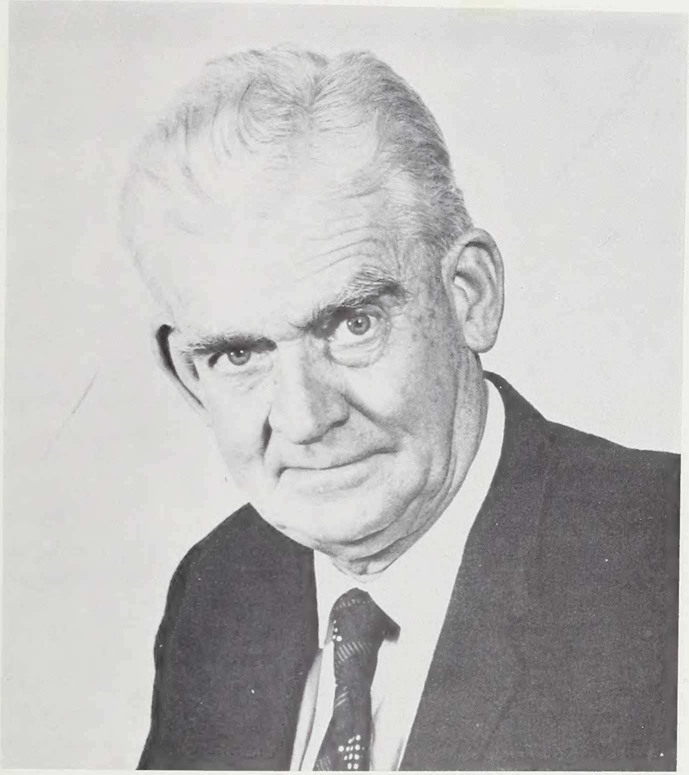

THIS VOLUME IS DEDICATED TO

JOHN PHILLIP HARRISON ACOCKS (1911—)

M.Sc. (U.C.T.)

respected ecologist and plant geographer of the Botanical Research Institute, known for his classic work, *Veld types of South Africa*, during the preparation of which he collected over 26 000 plant specimens (numbers) from all over the Republic, thereby enriching herbaria both here and overseas and greatly enhancing and adding to the knowledge of the flora of South Africa; in pasture science he formulated the principle of non-selective grazing which led to the original Acocks-Howell method of grazing management, the reappraisal of existing systems of management and the development of new systems; in 1975 he was awarded the gold medal of the Fertilizer Society of South Africa for his outstanding contributions to agriculture, while in 1976 he was awarded the South African Medal for Botany by the South African Association of Botanists and the Senior Captain Scott Memorial Medal by the South African Biological Society.

Jl S. Afr. Bot. 43 (1): 1–8 (1977)

A REVISION OF *XEROPLANA* BRIQ. (STILBACEAE)

J. P. Rourke
(Compton Herbarium, Kirstenbosch)

Abstract

The identity of *Xeroplana zeyheri* Briq. has been established and a new species, *Xeroplana gymnopharyngia* Rourke is described.

Uittreksel

'N HERSIENING VAN *XEROPLANA* BRIQ. (STILBACEAE)

Die identiteit van *Xeroplana zeyheri* Briq. is vasgestel en 'n nuwe soort, *Xeroplana gymnopharyngia* Rourke, word beskryf.

Introduction

Material of a member of the family Stilbaceae was collected by the author while climbing a relatively poorly explored series of peaks on the Langeberg, near Riversdale, in the southern Cape. Attempts to identify it met with failure as it could not be placed in any of the existing genera of the Stilbaceae, as described in the *Flora Capensis* and in Dyer's *The Genera of Southern African Flowering Plants* (1975). Five genera, namely *Campylostachys, Stilbe, Euthystachys, Xeroplana* and *Eurylobium* make up the family. All are characterized by having a distinctive ring of pubescence in the throat of the corolla tube. However, the throat of the corolla tube in the Riversdale material *(Rourke 1451)* was *completely glabrous*, thereby distinguishing it from all the above mentioned genera, although the bilabiate calyx and corolla suggested an affinity with the monotypic genus, *Xeroplana*. Accordingly, a careful examination of the type of *Xeroplana zeyheri* was essential since no other record of the species existed. The type was borrowed from the Delessert collection, Conservatoire et Jardin Botaniques, Geneva.

The type of *Xeroplana* Zeyheri

After dissecting several flowers on the type specimen it became evident that there were a number of serious errors in Briquet's description. The ovary was found to be single chambered, containing a single basal ovule; not two chambered with an ovule in each chamber as indicated in Briquet's description and drawing. Moreover, the style was found to arise from the abaxial side of the ovary and not

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Accepted for publication 26th August, 1976.

in a median position as shown in the type illustration. Briquet's misinterpretations are so misleading that the identity of *Xeroplana* has remained a baffling enigma that has perplexed botanists ever since the name was originally published (Dyer, 1975). The type locality, cited as, "In Africa australi" only served to heighten the mystery.

Fortunately, however, a label in Zeyher's hand, attached to the type, gives Zeyher's locality code as 90.9, a point which Briquet appears to have overlooked. From this code the exact locality of the type can be established. In his catalogue of Zeyher's collecting stations, Drège (1847) gives this locality as; "banks of the Riviersonderend at Appelskraal and on adjacent mountains". Recent collections from this locality have been made and compared with the type of *Xeroplana zeyheri* which they match in all details. Thus the name *Xeroplana zeyheri* Briq. can now be confidently applied to living populations in the field. An emended description of *Xeroplana zeyheri* follows later in this paper.

Xeroplana in Relation to Other Genera of the Stilbaceae

The generic status of *Xeroplana* may well be questionable in the light of the emended description of the type specimen. Superficially, *Xeroplana zeyheri* closely resembles *Stilbe ericoides* but may be separated from *Stilbe* by the bilabiate corolla. However, a very heterogeneous assemblage of material is filed under *Stilbe ericoides* in most herbaria, including some collections with distinctly bilabiate corollas. As a means of separating the two genera, the value of this character may therefore prove suspect. For the moment, however, *Xeroplana* is upheld and the unusual species which stimulated this investigation is here described as a new species of *Xeroplana*. It might even be deemed desirable at some stage in the future to give this latter species separate generic rank on the basis of the completely glabrous throat of the corolla tube—a character which is unique in the family Stilbaceae. But, as the Stilbaceae is already overburdened with monotypic genera it seems prudent to resist the temptation to create yet another, until a complete revision of the whole family can be undertaken. Clearly, a reappraisal of the generic limits will be a major consideration as Dyer (1975: 514) has already pointed out.

Xeroplana Briq. in Bull. Herb. Boiss. Ser (1) **4:** 336 (1896); Pearson in Fl. Cap. **5:** 188 (1901); Dyer, Gen of S.A. Fl. Pl. **1:** 516 (1975). Type *X. zeyheri* Briq.

Ericoid shrublets. *Leaves* ericoid, crowded, in whorls of 3 or 4, patent to imbricate. *Inflorescence* a sessile terminal spike 5–15 mm long. *Flowers* sessile, subtended by an ericoid bract and a pair of opposite, clasping, floral bracts. *Calyx* tubular, 5 lobed, slightly bilabiate, glabrous or pubescent. *Corolla* tubular, 5 lobed, bilabiate, abaxially curved, the two posterior lobes erect, the three anterior lobes distinctly narrower than the posterior lobes; throat of corolla either with or

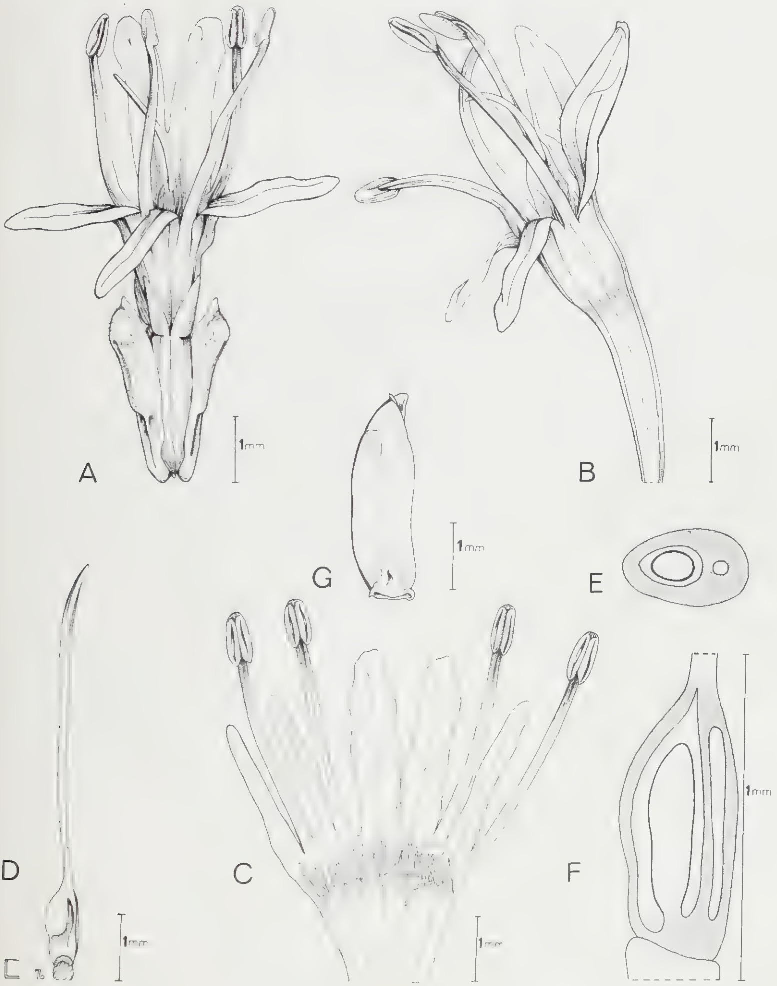

FIG. 1.
Xeroplana zeyheri Briq.
A. single flower and subtending floral bracts; B. lateral view of flower; C. corolla opened out to show ring of pubescence in throat; D. gynoecium showing ovary and style; E. transverse section of ovary; F. longitudinal section through ovary; G. fruit. (From *Rourke 1557*)

without a ring of pubescence. *Stamens* 4, inserted between the corolla sinuses of the anterior corolla lobes. *Style* filiform, exerted, arising from abaxial surface of the ovary. *Ovary* oblong, slightly flattened, potentially two chambered, but the abaxial chamber abortive leaving a single adaxial chamber with a solitary basal ovule.

KEY TO THE SPECIES OF *XEROPLANA*

Corolla tube with a distinct ring of pubescence in throat . . . . **zeyheri**
Corolla tube glabrous inside . . . . **gymnopharyngia**

Xeroplana zeyheri Briq. in Bull. Herb. Boiss. Ser. (1) **4:** 336 (1896); Pearson in Fl. Cap. **5:** 188 (1901); Phill, Gen. of S.A. Pl. (ed. 2): 635 (1951); Dyer, Gen. of S.A. Fl. Pl. **1:** 516 (1975). Type: On the banks of the Riversonderend at Appelskraal and on adjacent mountains, 500–4 000 ft, anno 1833 (90.9), *Ecklon and Zeyher* sub Stilbe sp. nov. No. 8 in herb. Delessert (G!).

A low, erect, rounded, highly divaricate shrublet to 50 cm in height, with a single main stem up to 3 cm in diameter. *Branches* slender, erect, villous at first becoming glabrescent to glabrous later. *Leaves* 3–6 mm long, 3 nate, ericoid, patent; linear-subulate to semi-terete, apex acute; minutely petiolate, margins revolute; pubescent on under surface, otherwise glabrous. *Inflorescence* a sessile terminal spike 5–12 mm long. *Flowers* solitary, sessile, each subtended by a leaf-like bract. *Floral bracts* two, opposite, 2 mm long, narrowly lanceolate, acute, prominently keeled and cymbiform distally; upper surface villous. *Calyx* tubular, very slightly bilabiate, abaxially curved, 2–2,5 mm long; composed of 5 fused sepals, sepal lobes lanceolate and ciliate, villous on inner surface; outer surface of calyx glabrous. *Corolla* tubular, bilabiate, 3–4 mm long, very slightly abaxially curved; throat slightly dilated with a ring of dense pubescence on the inner surface; the two posterior corolla lobes erect, oblong—obtuse, 1,5–2 mm long, the three anterior lobes patent, lanceolate acute 1 mm long. *Stamens* four, subequal, inserted between the corolla sinuses of the anterior lobes; posterior stamen absent; filaments filiform, 2 mm long; anthers basifixed dehising longitudinally. *Style* filiform, 6–7 mm long, glabrous, arising from the abaxial surface of the ovary. *Ovary* oblong, 1 mm long, slightly compressed in vertical plane, potentially 2 chambered but the abaxial chamber abortive, leaving a single adaxial chamber with a solitary basal ovule.

Xeroplana zeyheri has been recorded only from the moist southern slopes of

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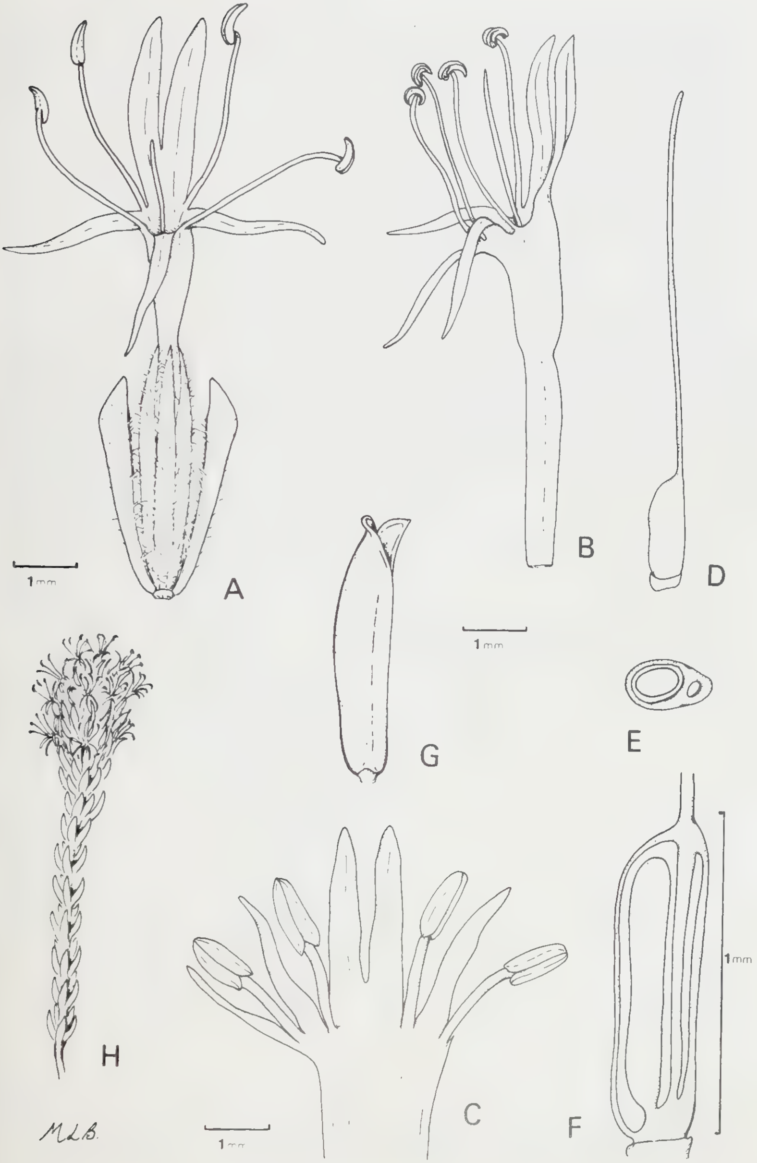
FIG. 2.
Xeroplana gymnopharyngia Rourke.

A. single flower and subtending floral bracts; B. lateral view of flower; C. corolla opened out; D. gynoecium showing ovary and style; E. transverse section of ovary; F. longitudinal section through ovary; G. fruit; H. complete inflorescence. (From *Rourke 1451*)


1 mm
A
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D
1 mm
E
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H
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C
F
1 mm
MLB.

the Riviersonderend mountains, directly above the village of Riviersonderend in the southern Cape, at elevations above 200 m. Although this species is evidently endemic to a very restricted area, fairly large numbers of individuals were observed at a site on a steep hillside in the Olifant's River valley, behind Tygerhoek Peak.

When flowering, the small rounded shrublets are fairly conspicuous as they are covered with inflorescences bearing bright pinkish flowers. Flowering commences in April and continues until the end of July. Although superficially similar to *Stilbe ericoides* which has a persistent lignotuber, *Xeroplana zeyheri* has a single main stem and is killed outright by veld fires.

SPECIMENS EXAMINED

CAPE PROVINCE—3419 (Caledon): Banks of the Riviersonderend at Appelskraal and on adjacent mountains, 500–4 000 ft (-BB), *Ecklon & Zeyher* sub Stilbe sp. nov. No. 8 in herb. Delessert (G); Kloof north of Riviersonderend, south eastern slopes above second water intake, 14.6.1974, *Goldblatt 2062* (NBG); Kloof in Riviersonderend mountains, near Riviersonderend village, slope with north aspect above Kloof, 13.4.1974, *Esterhuysen 33546* (BOL); Olifant's Kloof north of Riviersonderend, east slope of Olifant's river above uppermost weir, 15.7.1976, *Rourke 1557* (NBG).

Xeroplana gymnopharyngia Rourke, sp. nov., a fauce glabra corollae statim distinguitur.

Fruticulus effusus ad prostratus, densus ramosissimus, 30–50 cm altus. *Folia* 3–4 verticillata, dense imbricata vel interdum patentia, 3–7 mm longa, 1,5 mm lata, lanceolata-acuta, marginibus revolutis; glabra sed supra scabridiuscula. *Inflorescentia* dense spicata, sessilis, 1–1,5 cm longa. *Flores* sessiles, solitari, bractea foliaceo subtenti. *Bracteae florales* duae, oppositae, lineares acutae, carinatae, crassae apices versus. *Calyx* 5 mm longus, dense pilosus, tubularis-cylindraceus, 5-lobatus; lobi antici fissi profundior quam lobi postici. *Corolla* tubularis, bilabiata, 5 lobata, glabra; tubus 5–6 mm longus, glaber intus; lobi 3–4 mm longi; lobi postici erecti, anguste oblongi-obtusi; lobi antici anguste lanceolati-acuminati. *Stamina* 4, exerta; ad corolla inter sinubus anticis affixa. Fila 4–5 mm longa. *Stylus* 5 mm longus, filiformis, rectus, paginae abaxialis ovario exoriens. *Ovarium* oblongum, leviter compresseum; primus vitae stadiis biloculare sed uniloculare ad maturitatem, ovulo singulari basilari; loculus anticus abortivus.

A low, dense, much branched, sprawling to prostrate shrublet, forming mats up to 1 m in diameter and 30–50 cm in height. *Leaves* densely imbricate, occasionally spreading, 3–7 mm long, 1,5 mm wide, ericoid, in whorls of 3 or 4, lanceolate-acute with revolute margins; minutely petiolate; glabrous but minutely scabrous on upper surface. *Inflorescence* a dense spike, 1–1,5 cm long, sessile. *Flowers* solitary, sessile, subtended by a leaf-like bract. *Floral bracts* 2, opposite, 4–5 mm long, linear acute, prominently keeled and thickened towards apex, membranous and hyaline proximally; sparsely pilose. *Calyx* 5 mm long, tubular-cylindric, 5 lobed, the 2 anterior lobes more deeply cleft than the 3 posterior lobes; outer surface densely pilose but becoming glabrous proximally. *Corolla* tubular, bilabiate, 5 lobed, glabrous; tube 5–6 mm long, lobes 3–4 mm long, the two posterior lobes erect, narrowly oblong, obtuse, the 3 anterior lobes narrowly lanceolate, acuminate. *Stamens* 4, exerted; inserted at mouth of corolla between the sinuses of the 4 anterior corolla lobes. Filaments 4–5 mm long. Anthers basifixed dehiscing by 2 longitudinal slits. *Style* 5 mm long, filiform, straight, arising from the abaxial end of the ovary, terminating in a simple stigma. *Ovary* oblong, slightly laterally compressed, glabrous; the style arising assymetrically on the abaxial surface of the ovary; potentially 2-chambered but the abaxial chamber abortive, leaving the adaxial chamber with a single basal ovule. *Fruit* 5–6 mm long, cylindric, laterally compressed, curved, brown and shiny, glabrous, dehiscing into 2 valves at apex only. *Seed* not seen.

DIAGNOSTIC CHARACTERS

The absence of pubescence in the throat of the corolla at once distinguishes *Xeroplana gymnopharyngia* from all other members of the Stilbaceae.

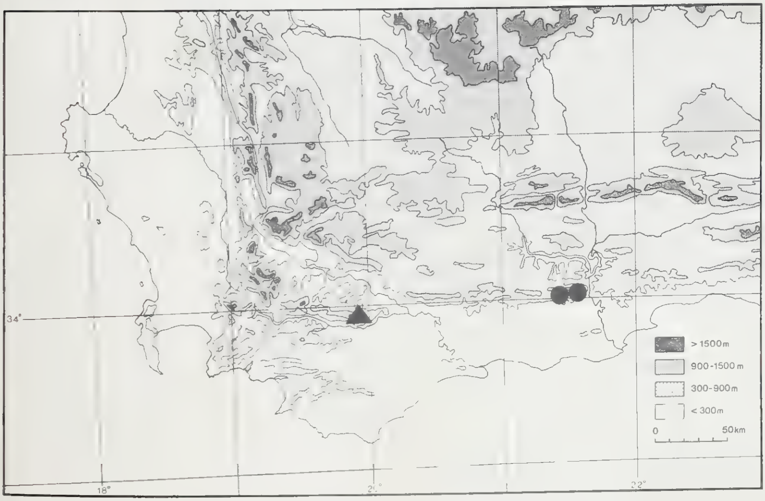

FIG. 3.
Distribution of *Xeroplana zeyheri* (triangle) and *X. gymnopharyngia* (dots).

Type Material: Langeberg mountains, Riversdale, above the farm Langkloof on "Annex Langekloof", along the summit ridge, 7.11.1974, *J. P. Rourke 1451* (NBG, holotype; PRE, BOL, K, MO, G, S, isotypes).

Only two collections of this species appear to have been made: originally by Dr. J. Muir in 1913 and more recently by the author in 1974. Little, therefore, is known about its distribution range apart from the fact that it extends along the landward ranges of the Langeberg from Langkloof Farm in the west to Witelsberg in the east, a distance of some 15–20 km. The mature plants form dense mats up to 1 m in diameter, sprawling over rocky Table Mountain Sandstone crags at elevations ranging from 900–1 200 m. Flowering specimens were recorded in November but the flowering season probably continues into December and even early January. The corolla is a pale dusky pink.

SPECIMENS EXAMINED

CAPE PROVINCE—3321 (Ladismith): Langeberg mountains, Riversdale, above the farm Langkloof on "Annex Langekloof", along summit ridge (-CD), 7.11.1974, *Rourke 1451* (NBG, PRE, BOL, K, MO, G, S); Summit of Langeberg above Witte Els, Nov. 1913, *Muir 1251* (PRE, BOL).

ACKNOWLEDGEMENT

I wish to express my thanks to the Director of the Conservatoire et Jardin Botaniques, Geneva, for arranging the loan of the type specimen of *Xeroplana zeyheri* Briq.

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Jl S. Afr. Bot. 43 (1): 9–20 (1977)

NEW RECORDS OF *BRACHYSTELMA*

R. A. Dyer
(Botanical Research Institute, Pretoria)

Abstract

Brachystelma perditum, B. australe, B. bruceae, B. petraeum and *B. alpinum* are described for the first time.

Uittreksel

NUWE VERSLAE VAN *BRACHYSTELMA*

Brachystelma perditum, B. australe, B. bruceae, B. petraeum en *B. alpinum* is vir die eerste maal beskrywe.

In general, specimens of *Brachystelma* are few and far between in the veld. On occasions a species may be found to be locally common but very rarely widely common. In consequence species are for the most part imperfectly known and their range of distribution uncertain. The genus was established by Robert Brown ex Sims in *Curtis's Botanical Magazine* t. 2343 (1822) on a plant "communicated in blossom in June last by Mr. Joseph Knight of the Exotic Nursery in the Kings Road".

Carl Thunberg was probably the first botanist to collect a specimen of *Brachystelma* at the Cape during his Travels 1770–1773. He described it briefly in his *Proderomus* in 1794 under the name *Stapelia caudata* but recorded no precise locality. His plant could well have been from the Cape Peninsula but the presence of the species there was not authenticated until nearly 200 years later.

In 1908, N. E. Brown in his monograph of the genus in *Flora Capensis*, could only suggest the presence of the species on the Peninsula. Pillans made no mention of it in the *Flora of the Cape Peninsula* in 1951 and confirmation came fortuitously only when an area near Kommetjie was being cleared for a coloured peoples housing estate in 1968. A member of the Kirstenbosch National Botanic Garden staff picked up a single damaged tuber in full bloom. Mr. Harry Hall, formerly curator of the succulent collection at Kirstenbosch, drew attention to the surprisingly large size of the tuber which measured about 15 cm in diameter with several annual stems. It was a remarkable find.

There is only one other species of *Brachystelma* on the Peninsula, *B. occidentale* Schltr., discovered by Schlechter near Smitswinkel in 1892 and not

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recorded again in spite of recent attempts to locate it. It gives limited satisfaction to base a new species on a single collection for it is obviously inadequate to reveal the natural variation and limits of distribution of the plant in question. On the other hand to refrain from giving a name to what is obviously an unrecorded taxon, such as *B. perditum, B. alpinum* and *B. petraeum* described below, may leave interesting records buried for further centuries. Each one of these taxa may be common in its favoured environment and it is hoped that some enthusiasts will regard a fuller knowledge as its own reward. Col. R. Bayliss, Dr. O. M. Hilliard and others have been helpful in various ways and I am pleased to express my sincere appreciation of the interest and help I have received.

Brachystelma perditum R. A. Dyer sp. nov., affine *B. caudato* (Thunb.) N. E. Br. sed coronae lobis interioribus intus conspicue alatis distinguitur.

Herba perennis, (tuberosa ?), ramosa, ± 7 cm alta. *Folia* ± ovato-elliptica, 1,5–2 cm longa, ± 5 mm lata, crassiuscula. *Flores* 2–aliquot extra axillares, pedicellis ± 10 mm longis puberulis. *Sepala* lineari-lanceolata, 2–2,5 mm longa. *Corolla* ± 2,5 cm longa, brunea extus sparsim pubescens, intus puberula et sinos versus pilis longis induta; tubus campanulatus, 4–5 mm profundus; lobi lineari-lanceolati, ± 2,0 cm longi. *Corona* breviter basi connata; lobi exteriores marsupiiformes margine bilobulato, lobis interioribus confluentes; coronae lobi interiores incumbentes intus conspicue alati.

Type: NATAL: 1800 m 15/10/1907, *J. Wylie* in Herb. *Medley Wood 11229* (NH 12260 holo.).

Description—Perennial herb with tuberous rootstock, producing an annual stem up to about 7 cm tall, branched, possibly sparsely pubescent (slightly mouldy). *Leaves* more or less ovate-elliptic, 1,5–2 cm long, ± 5 mm broad, somewhat fleshy. *Flowers* 2–several from a flowering eye, extra axillary; peduncle rudimentary; pedicels ± 10 mm long, puberulous. *Sepals* linear-lanceolate, 2–2,5 mm long. *Corolla* ± 2,5 cm long, united for ± 3,5 mm, brown; tube campanulate ± 3 mm deep; lobes linear-lanceolate, ± 20 mm long, apparently nearly flat and thinly pubescent on outside and inside and with long stiff (white ?) hairs near the sinuses. *Corona* arising slightly above base of staminal column with slightly spreading, 5-indented base, forming 5 pockets with outer margin obtusely bilobuled and confluent on the margins with the inner corona lobes; inner lobes short, incumbent, with ear-like lateral expansions from the under surface covering the anthers. *Pollinia* subcircular, compressed with translucent inner margin, attached by short caudicles to shortly winged carrier nearly as large as the pollinia (not as drawn by M. Franks) (Fig. 1).

It will be noted that *B. perditum* is based on a single collection. The specimen has not been matched since it was collected in October 1907 by J. Wylie, curator of the botanic garden in Durban. Wylie collected plant material for J. Medley

Wood, director of the garden and herbarium and this particular specimen bears the Medley Wood number 11229 and Natal herbarium number 12260 with the locality Niginya, 6 000 ft. (1 800 m). Neither register gives further details of the locality and it cannot be traced. The spelling of the name is suspect and the nearest suggestion would be Nginya which also is not recorded. Medley Wood was in the habit of publishing annual reports on the activities of the garden but it so happens that no report was issued for 1907–1908 because of financial stringency at the time. The altitude of 1 800 m is a guide which suggests the foothills of the southern Natal Drakensberg. Even this is a very large area in which to search optimistically for a small rare herb which is recognisable for only a relatively short period of the year.

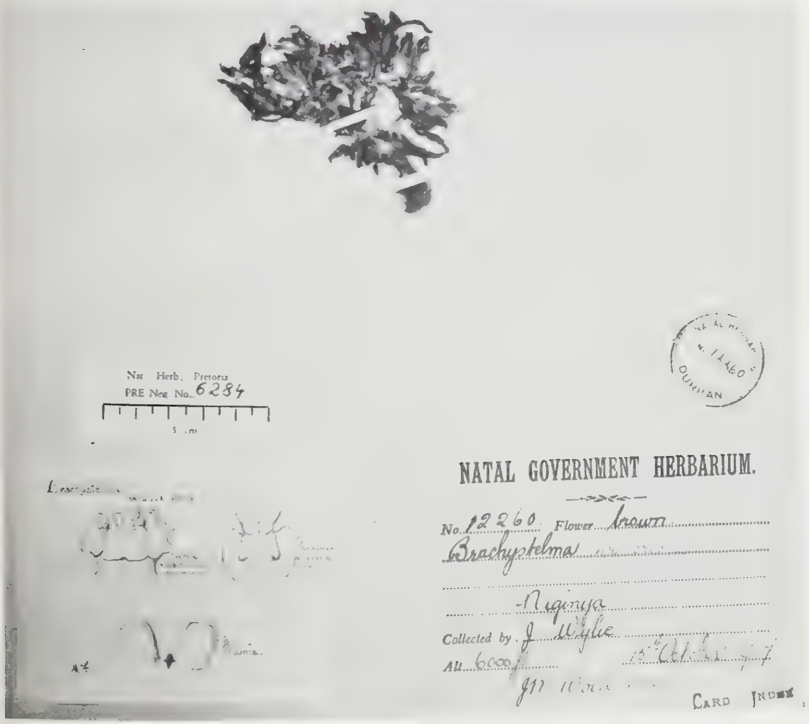

FIG. 1.
B.perditum, photograph of *Wylie 12260* in Natal Herbarium, Durban, with drawings of dissections by Millicent Franks in bottom left corner, x½.

Note: While the above was in press Mr Pierre du Toit, recently transferred to BRU, Natal Herbarium, made a further search for possible clues to the correct locality record. He found several other specimens collected by Wylie at the same time. These established the fact that in October 1915 Wylie was on a collecting exhibition via Ntabamhlope (recorded as Tabamhlope) to Giants Castle in the Drakensberg. A few miles north of the Ntabamhlope Mountain and Police Station is the mountain Nyiginye. There is no doubt in my mind that Wylie's Niginya was a variant spelling of this and that in this area is the greatest hope of rediscovering *B. perditum.*

It is obvious that the specimen created an early interest because Millicent Franks, artist to Medley Wood, made drawings of the coronal structure which are attached to the herbarium sheet NH 12260 (Fig. 1); the identification is given as near *B. crispum* (= *B. caudata*) and on the base of the label is written "unique". The unique structure is seen in the winged inner corona-lobes clearly drawn by M. Franks. The accuracy of the drawing has been confirmed except that the pollen-carrier is larger than depicted. Until a fresh flowering specimen is discovered, the present scrap is the only evidence of a species which may have a lost cause—perdition its unkind fate among many other flowers doomed to bloom unseen.

Brachystelma australe R. A. Dyer, sp. nov., *B. pulchello* (Harv.) Schltr. affine, corolla latiore, intus pilosa, tubo 2–3 mm profundo, conspicue purpureo-vel luteo-fasciato differt.

Herba perennis tuberosa, basi ramosa; rami patentes vel diffusi, spasim breviter pilosi vel subglabri. *Folia* ± elliptico-lanceolata, basin versus attennata, 10–20 mm longa, 3–8 mm lata, glabra vel margine sparsim ciliato. *Flores* 1 extra axillares, pedicellis ± 10 mm longis. *Sepala* lineari-lanceolata, 3–4 mm longa. *Corolla* ± 20 mm diam., breviter late campanulata; tubus 2–3 mm profundus, supra plerumque pilosus, transverse fasciatus; lobi ovato-lanceolati, 8–10 mm longi, basi ± 4 mm lati, patenti-recurvi, apicem versus margine recurvato, sparsim pilosi. *Corona* breviter tubulata, lobis exteriosibus marsupiiformibus, margine ad medium anguste V-formato vel rimato; lobi interiores lanceolati, incumbenti.

Type: TRANSKEI—3129 (Port St. Johns): Lupatane waterfall, about 28 km east of Lusikisiki near coast (-BD), 12/12/1972, *O. Leistner 3504* (PRE, holo.).

Perennial herb with tuberous rootstock. *Tuber* irregular, sometimes becoming exposed above ground, with 1—few 'growing' eyes. *Stems* few—several produced annually, spreading or somewhat tufted, sparsely and minutely pubescent. *Leaves* mainly elliptic-lanceolate tapering to the petiole-like base, 10–20 mm long, 3–8 mm broad, glabrous or with few hairs. *Flowers* 1 from a flowering eye, produced laterally; pedicel slender, 7–10 mm long. *Sepals* linear-lanceolate, 2–4 mm long. *Corolla* ± 20 mm diam., broadly campanulate to saucer-shaped, divided about two-thirds to base, sparsely pubescent with spreading hairs or glabrous round corona; tube 2–3 mm deep, transversely purplish marked on yellow round corona (or purplish with yellow markings) and sometimes extending for nearly full length of lobes, sometimes blotched; lobes ovate-lanceolate, attenuate, 8–10 mm long, ± 4 mm broad at base with margins variably recurved, spreading-recurved from tube. *Corona* united at base forming 5 pockets, with outer margin narrowly V-shaped or slit to half way, confluent laterally with the inner lobes; inner lobes ± lanceolate, incumbent on the anthers but not exceeding them. *Pollinia* about 0,3 mm long and broad with the inner translucent margin angled at the apex, connected by short caudicles to the carrier; carrier with small lateral swellings or pseudo-wings (Fig. 2).

The accepted distribution range of *B. australe* is from near Port St. Johns in the Transkei northwards along the coastal region to the neighbourhood of Port Shepstone at Oribi Gorge. *Leistner 3504* was designated as the holotype because the material was preserved direct from the wild habitat whereas the other specimens are mainly from tubers in cultivation.

TRANSKEI—3129 (Port St. Johns): Umsikaba River (-BD), 10/11/1970, *R. G. Strey 10110;* Lupatane waterfall, about 28 km E. of Lusikisiki on coast, 12/12/1972, *O. Leistner 3504;* Jan. 1937, *H. J. Eyling* (BOL); *H. C. Bellew* (BOL); *D. McMurtry* (NBG).
NATAL—3130 (Port Edward): on sandstone rocks, 240 m. 21/12/1960, *S. Kitching 67;* 17/10/1958, *S. Kitching,* PRE *54351.*
—3030 (Port Shepstone): Umtamvuma Forest Reserve (-CB); 15/12/1967, *R. G. Strey 6973* (NH); Gilbralta farm, 8/11/1970, *R. G. Strey 10610* (NH).

The specimens collected by H. C. Bellew and H. G. Eyling and grown at the National Botanic Gardens, Kirstenbosch in 1937, were regarded as an undescribed species at the time and have remained unnamed until now. There is a close relationship with *B. pulchellum* (Harv.) Schltr., *B. modestum* R. A. Dyer and others, but a narrow view of species, guided by distribution records, seems essential in this group because a broad view leads to an untenable conglomerate.

Brachystelma bruceae R. A. Dyer, sp. nov., nom. nov.; *B. pulchellum* Bruce in Flower Pl. Afr. **29:** t. 1121 (1952), non Schltr.

Herba perennis affinis *B. pulchello* (Harv.) Schltr., corolla majore, concolorata, haud tubulosa, lobis longioribus rotatis differt.

Type: TRANSVAAL—2530 (Lydenburg): Kaapsehoop (-DB), 1650 m. Nov. 1949, *L. E. Codd 5756* (PRE, holo.).

Perennial herb with tuberous rootstock. Tuber up to about 7 cm diam., sometimes developing tuberous outgrowths from the upper surface and producing

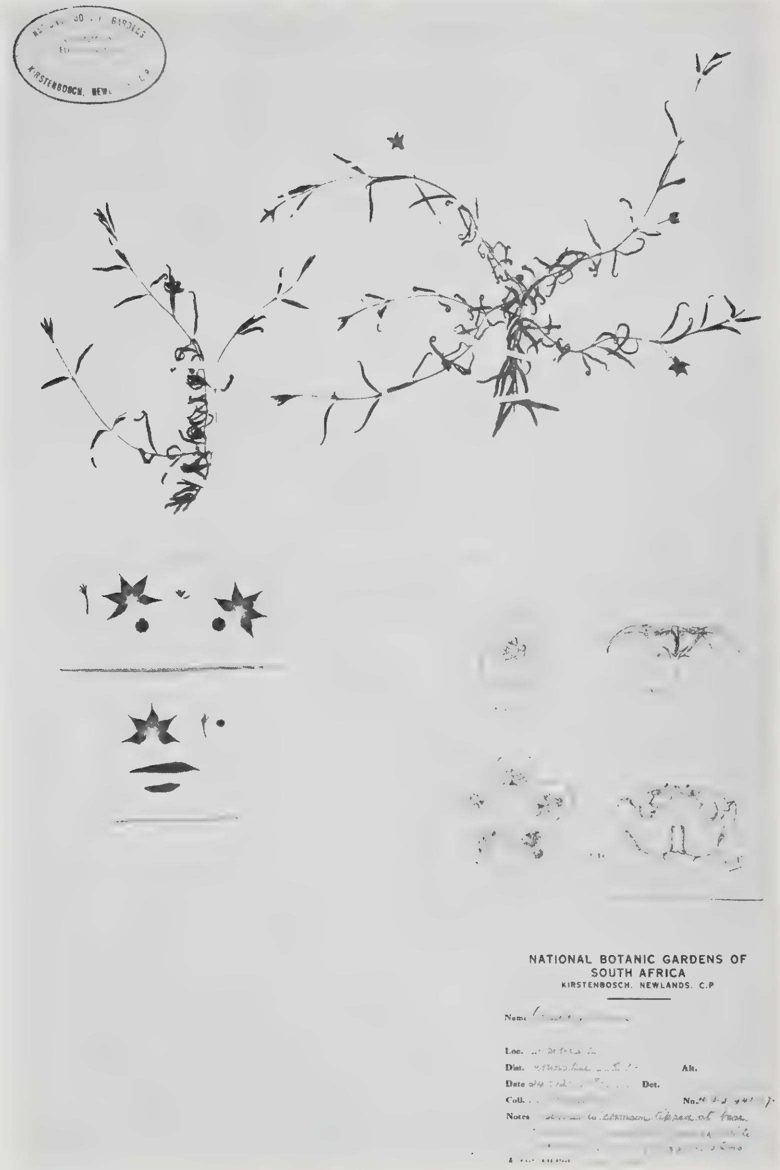

FIG. 2.

B. australe, photograph of specimen in Compton Herbarium, Kirstenbosch with drawings made from living material in garden.

1—few annual stems; stems prostrate sometimes freely branched near base, up to about 12 (20) cm long, purple-tinged, minutely crisped-pubescent. *Leaves* shortly petiolate, ovate to broadly ovate, slightly fleshy, usually 10–15 mm long 5–10 mm

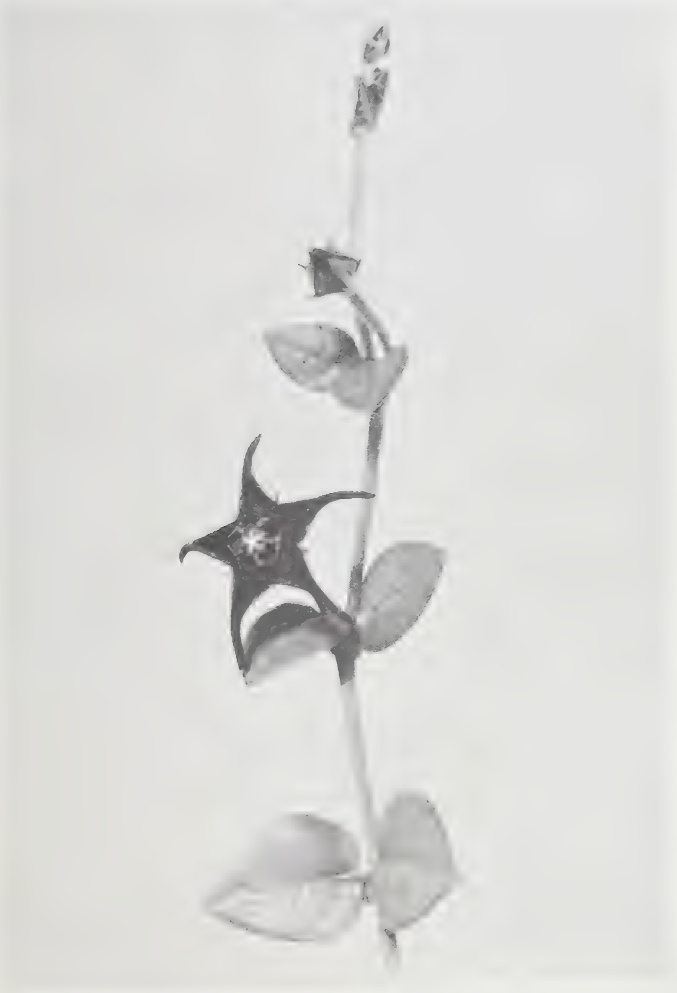

FIG. 3.
B. bruceae, branch from type plant in cultivation at B.R.I., *Codd 5756* from Kaapschehoop.

broad, dark purple-green above, paler underneath, glabrous except for few minute crisped hairs on margin and midrib below. *Flowers* solitary, extra-auxillary; pedicels 7–15 mm long, minutely crisped-pubescent. *Sepals* linear-lanceolate, ±3 mm long. *Corolla* 1,5–1,8 mm diam., divided two-thirds to three quarters to base with no tube, concolorous, purple-maroon, darker towards tips, glabrous, lobes ovate-lanceolate, rotate, with margins recurved towards tips, becoming somewhat recurved. *Corona* purple-maroon, cup-shaped at base 1,5 mm deep forming 5 pockets with their outer margin emarginate, confluent with inner corona-lobes; inner corona-lobes arising slightly within the outer, oblong, incumbent on the anthers (Fig. 3).

The typical form is known only from the Kaapsehoop mountains of the eastern Transvaal, where L. E. Codd recorded it in whitish sandy soil over Black Reef Quartzite with sparse grass cover.

TRANSVAAL—2530 (Lydenburg) Kaapsehoop (-DB), 1650 m., Nov. 1949, *L. E. Codd 5756, 6475*, Dec. 1937, *F. Z. van der Merwe s.n.;* Godwan River Station, Jan. 1923, *J. H. and J. Davison 7.*

When Eileen Bruce described the plant figured on plate 1121 in *Flowering Plants of Africa,* 1952, under the name *Brachystelma pulchellum* (Harv.) Schltr. she remarked that it differed from the description of the typical form from Natal in the larger concolorous purple-chocolate flowers with no trace of transverse yellow lines at the base of the lobes. In addition the Natal plants do have a shallowly saucer-shaped corolla as compared with the completely expanded flat corolla of the plants from the eastern Transvaal. To retain the plant illustrated on *Flower. Pl. Afr.* t. 1121 as a form *B. pulchellum* creates further taxonomic problems in deciding the relationship to closely related taxa such as *B. coddii* and the subspecies of *B. bruceae* which follows. The isolation between the forms must be of very long standing.

Brachystelma bruceae subsp. **hirsutum** R. A. Dyer, subsp. nov., corolla concolorata, pilis purpureis hirsutis, differt.

Type: TRANSVAAL—2531 (Komatipoort): ±10 km. S. of Barberton, *Stirton 1841* (PRE, holo.)

Perennial herb with small tuber. *Stems* produced annually, becoming prostrate. *Leaves* ovate to elliptic-ovate, ±1 cm long, slightly fleshy. *Flowers* 1 (2) extra-axillary; pedicel ± 1 cm long. *Corolla* 1,6–1,8 (2,5) cm diam., divided two-thirds to four-fifths to base, covered on upper surface with long purplish hairs, concolorous, without tube; lobes rotate, ovate-lanceolate to linear-lanceolate, 6–9 mm long with recurved margins. *Corona* shortly united at base for about 2 mm forming 5 pockets with V-U shaped outer margin, and confluent with the inner lobes; inner lobes, arising slightly within the outer and with a slight ridge at their base, incumbent on the anthers. *Pollinia* 0,25–0,3 mm long, somewhat compressed, with inner translucent margin and slightly pointed at upper extremity, attached by short caudicles to shortly winged carrier.

TRANSVAAL—2531 (Komatipoort): ±10 km S. of Barberton on Mendor Farm, near Ngomangoma Stream, stony outcrop about 50 m above stream in rock-fissures of plateau (-CC), 30/3/76, *C. H. Stirton 1841;* Nov. 1938, *F. Z. van der Merwe s.n.*

In 1937 and 1938 the late F. Z. van der Merwe, a medical man with a keen interest in botany, collected single specimens of *Brachystelma* in the eastern Transvaal which only now receive positive identifications under *B. bruceae* and *B. bruceae* subsp. *hirsutum*, respectively. Neither of the specimens received a precise locality at the time of incorporation into PRE and remained unmatched for many years. The difference between them is in the concolorous purplish-hirsute corolla of *B. bruceae* subsp. *hirsutum* and this appears to be linked with a slightly greater diameter and more deeply divided corolla. There is very little if any constant difference in the coronal structure.

Brachystelma petraeum R. A. Dyer, sp. nov., *B. pulchello* (Harv.) Schltr. et *B. australi* R. A. Dyer affine, ambobus habitu, coronae lobis exterioribus margine breviter bidentatis, corollae lobis pilis caducis ciliatis differt.

Herba perennis humilis tuberosa. *Rami* pauci vel plures patentes puberuli. *Folia* elliptico-ovata vel elliptico-lanceolata, 5–12 mm longa, 3–7 mm lata, breviter petiolata, glabra vel sparsim puberula, *Flores 1*, extra axillares producti; sepala ± lineari-lanceolata, 3–4 mm longa. *Corolla* ¾ dissecta, ± 20 mm diam. purpureo-maculata; tubus campanulatus, 3–5 mm longus; lobi ovato-lanceolati, 7–10 mm longi, attenuati, margine pilis longis caducids induto. *Corona* basi breviter connata; lobi exteriores marsupiiformes, margine u-vel v-emarginato, breviter bidentato; lobi interiores ± oblongi valde incumbentes. *Pollinia* subpyriformia, circiter 0,3 mm longa. *Folliculi* cylindrici, ± 2,5 cm longi.

Type: NATAL–2930 (Pietermaritzburg): Byrne Valley Escarpment, 1500 m alt., 13/11/1975, *O.M.Hilliard 5601* (PRE, holo., NU,iso.)

Perennial herb with tuberous rootstock. *Tuber* comparatively large, irregularly shaped, wedged between rocks and in fissures, with one or few growing eyes. *Stems* produced annually, tufted or somewhat diffuse, branched, puberulous. *Leaves* elliptic-ovate or sometimes elliptic-lanceolate, 5–15 mm long, 3–8 mm broad, usually shortly petiolate, somewhat fleshy, glabrous or with few short hairs, mainly on margin. *Flowers* solitary, extra axillary; pedicels 10–20 mm long, puberulous. *Sepals* lanceolate to linear-lanceolate, 3–4 mm long. *Corolla* divided about three-quarters to base more or less 20 cm diam, dull purple-brown outside, mottled red on mustard-yellow within; tube shortly campanulate, 3–5 mm long; lobes from ovate-lanceolate base tapering to apex, 7–10 mm long; margin with long soft caducous hairs concentrated near sinuses. *Corona* slightly stipitate, saucer-shaped at the base, forming 5 pockets with narrowly U- or V- shaped margin, extending into 2 short teeth, confluent laterally with inner corona-lobes; inner lobes incumbent on backs of anthers and nearly meeting over the staminal column, with or without a small basal tooth. *Pollinia* subpyriform, ± 0,3 mm long, with a translucent inner margin, attached to carrier by very short caudicles; carrier with small lateral wings. *Follicles* cylindric, ± 2,5 cm long (Fig.4).

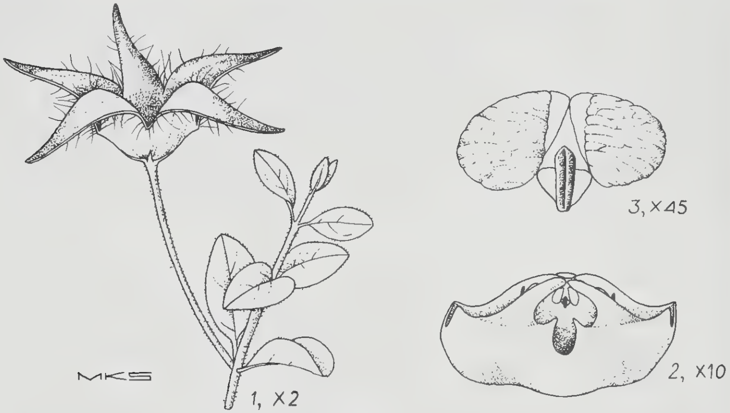

FIG. 4.
B. petraeun, drawn from type material in spirit, *Hilliard 5601*, Richmond, Natal.

This species is known only from the type collection from the Byrne Valley Escarpment near Richmond, Natal. It was thought at first to be able to include it in *B. pulchellum* (Harv.) Schltr. but the several differences in habit, size and ciliation of the corolla and difference in coronal structure made this course unrealistic. There is some affinity also with the newly described species *B. australe* but the habit, the pubescence and colouration of the corolla and coronal details are sufficient distinctions, supported by the wide difference between the coastal and rocky mountain habitats.

Brachystelma alpinum R.A. Dyer, sp.nov., corollae lobis pilis longis vibratilis ciliatis, coronae lobis exterioribus marsupiiformibus margine late U-formato distinguitur.

Herba tuberosa humilis delicata, simplex vel parce ramosa; tuber 2,5–3 cm diam., leviter depressum. *Rami* usque 5 cm longi, erecti vel demum patentes, minute puberuli. *Folia* ovata, late ovata vel oblongo-lanceolata, 1–2 cm longa, glabra vel margine sparsim papillato-ciliato, breviter petiolata. *Flores* 1, extra

axillares, pedicellis ± 1 cm longis. *Sepala* lineari-lanceolata, ± 3 mm longa. *Corolla* 1,3–1,5 cm diam., breviter tubulata, extus leviter rugosa, intus pilosa; tubus late campanulatus 2 mm profundus, transverse fasciatus; lobi ± triangulares, 4,5 mm longi, basi 3 mm lati, apicem versus leviter replicati, sinos versus pilis longis vibratilis caducis ciliatis. *Corona* breviter tubulata, lobis exterioribus marsupiiformibus, margine late U-formato; lobis interioribus oblongis incumbentibus.

Type: LESOTHO–2928 (Marakabei): 2300–2500 in alt., Feb, 1975, *R.D.A. Bayliss 819* (PRE, holo.).

Perennial herb with tuber up to about 3 cm diam., slightly depressed, producing annually 1(2) delicate stems 3–5 cm tall (elongating in cultivation and becoming procumbent) minutely puberulous. *Leaves* variable, from broadly ovate to narrowly oblong-lanceolate, 1–2 cm long, glabrous or with few small papillae-like hairs on margin, shortly petiolate. Flowers 1, arising extra axillary from second or third node, possibly 2 on occasions; pedicel slender, about 1 cm long. *Sepals* linear-lanceolate, about 3 mm long. *Corolla* 1,3–1,5 cm in diam., slightly rugose outside, united in the lower half; tube broadly campanulate, 2 mm deep,

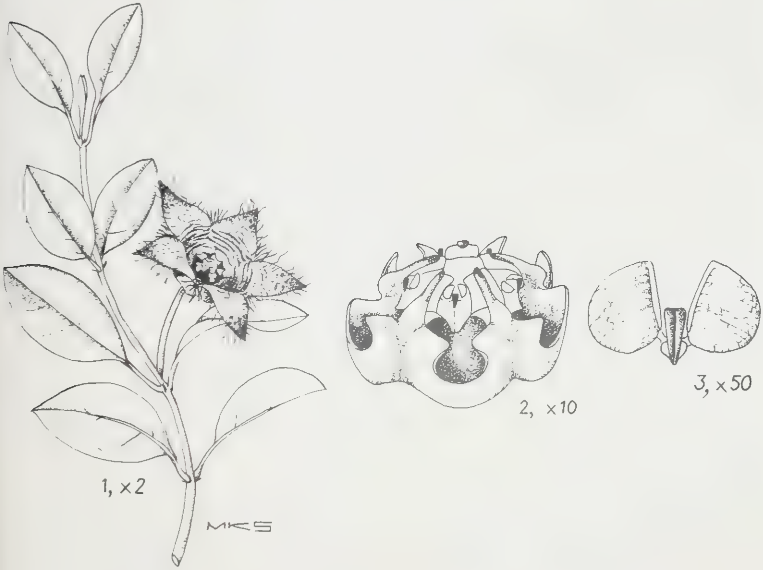

Fig. 5.
B. alpinum, drawn from type material in spirit, *Bayliss 819*, Lesotho.

transversely banded; lobes triangular, 4–4,5 mm long, 3 mm broad at base, with margins slightly replicate towards tips, with sparse, spreading pubescence on lower half and with few long vibratile, caducous hairs towards the sinuses. *Corona* somewhat fleshy, shortly tubular at base; outer 3 mm diam. and high, forming 5 pockets within and with the outer margin broadly U-shaped and confluent with the inner lobes; inner lobes oblong, incumbent on the anthers but not exceeding them. *Pollinia* subglobose, about 0,25 mm long with straight translucent inner margin, attached by short caudicles to a very shortly winged carrier (Fig.5).

Tubers were found on a hill behind the store at Ramas Gate in shale formation at an altitude between 2 300–2 500 m where plants are subject to high rainfall and intense cold. As far as my records go this is the highest altitude from which a species of *Brachystelma* has been collected in Southern Africa. Col. Bayliss obtained several tubers in February 1975 of which he presented two to me at the BRI, Pretoria, one to Miss G. Britten at the BRU, Grahamstown, and retained the rest to grow at his residence in Grahamstown. Those at BRI produced new herbaceous stems but failed to flower. One flowered for Col. Bayliss in Oct.-Nov. 1975. This latter was photographed and placed in preservative solution before being forwarded to BRI, where it was drawn and described.

In January 1976 a tuber at BRU, Grahamstown, produced an almost identical flower to *Bayliss 819* but it was associated with a label for a tuber collected by Col. Bayliss, No. 4763 together with *Stapelieae* and a *Ceropegia* in an arid part of Swaziland in 1969. *Bayliss 4763* had not flowered previously. To me it seems probable that the original *Bayliss 4763* had perished and that the label was inadvertently transferred by William Tsuane to the tuber from Lesotho, *Bayliss 819*. William Tsuane was appointed by me to the Botanical Survey staff in Grahamstown in 1925 and has since given 51 years of conscientious service to South African botany, but as Col. Bayliss admits, he is now almost in his dotage and might conceivably have mixed the labels. It would not be the first time for such a simple mishap to have occurred. It seems the only reasonable explanation for the discrepancy in the locality records. I cannot conceive that this miniature species could occur naturally in two such different habitats about 500 km apart.

Jl S. Afr. Bot. 43 (1): 21–39 (1977)

STUDIES IN CYPERACEAE IN SOUTHERN AFRICA: 9. *CYPERUS PROLIFER* LAM. AND SOME ALLIED SPECIES

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Abstract

The biology of *C. prolifer* Lam. and its allies *C. sensilis* Baijnath and *C. x. turbatus* Baijnath is discussed. The value of traditional diagnostic criteria is examined and data from fields of morphology, cytology, anatomy and phytochemistry employed to justify the specific recognition of these taxa. Keys to their identification are provided.

Uittreksel

STUDIES VAN CYPERACEAE IN SUIDELIKE AFRIKA: 9. *CYPERUS PROLIFER* LAM. EN 'N PAAR VERWANTE SOORTE

Die biologie van *C. prolifer* Lam. en sy verwante soorte, *C. sensilis* Baijnath en *C. x turbatus* Baijnath, word bespreek. Die waarde van tradisionele diagnostiese kenmerke word ondersoek. Morfologiese, sitologiese, anatomiese en fitochemiese kenmerke word gebruik om tussen hierdie soorte te onderskei. Sleutels word verskaf.

Introduction

The coastal vegetation of Natal and Zululand includes the southern limits of many tropical species. One such species is *C. prolifer* Lam., the so-called "miniature papyrus." Associated with *C. prolifer* are two new taxa *C. sensilis* Baijnath and *C. x turbatus* Baijnath which have a more restricted distribution being limited, we believe, to the east coast of Southern Africa.

The nomenclatural confusion which surrounds *C. prolifer* has been discussed earlier (Getliffe and Baijnath, 1976) and the present paper compares this taxon and its allies, *C. sensilis* and *C. x turbatus* (Baijnath, 1976), and aims to justify their recognition as species and to provide adequate keys to their identification.

Taxonomic position within *Cyperus*

By virtue of their umbellate inflorescences, digitate or solitary spikelets and wingless rhachillas, all three species are placed within the subgenus *Pycnostachys* (Clarke, 1897), while their leafless habit places them in section 5 *Textiles* of this subgenus (Clarke, 1902).

Within this section, diagnostic characters include size and number of bracts, culm shape and ray number. Thus, Clarke distinguished two species, *C. prolifer*

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Lam. and *C. isocladus* Kunth (now regarded as synonyms, Getliffe and Baijnath, *l.c.*) solely on basis of culm shape. As Clarke pointed out, the value of such a differentiation is debatable and this and other diagnostic and descriptive characters were studied and will be discussed below.

MATERIAL

Material for the comparison of the three species and study of variation within species was obtained from mass collections of 20 specimens gathered at random from populations from the range of distribution of each taxon.

Appendix 1 provides citations of specimens used in this study.

MORPHOLOGICAL FEATURES

(i) *Culm shape*

Though several authors have expressed reservations about the wisdom of relying on culm shape as a diagnostic criterion (Boeckeler, 1867–68, Clarke, 1897, Forbes, 1969) it is, nevertheless, often used in keys to distinguish pairs of similar species.

There are two serious disadvantages in this use of culm shape as a diagnostic criterion. The first is the lack of uniformity in terminology, the second the lack of adequate information on variation within populations and indeed within a single specimen.

In the analysis of descriptive terms used for culm shapes in *C. prolifer* Lam. it was apparent that there was little consistency in the use of the terms "triquetrous", "trigonous" and "triangular" and some confusion over the exact definitions of these terms.

According to Featherley (1965) the terms "trigonous" and "triangular" are synonyms while Stearn (1973) remarks that "trigonous" and "triquetrous" are usually considered synonyms. These two latter terms were used to separate *C. isocladus* Kunth and *C. prolifer* Lam. (Kunth, 1837).

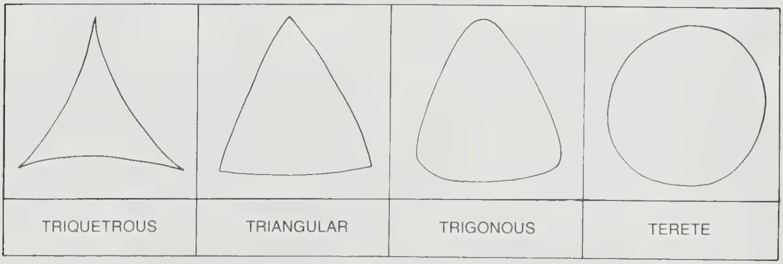


FIG. 1
Culm shape in *Cyperus* and the descriptive terminology used in this text.

In this study, the terms "terete", "trigonous", "triangular" and "triquetrous" are used to describe culm shape in cross section and the shapes they describe are illustrated in Fig. 1.

Thus, "terete" is applied to culms which are circular in trans sectional outline, "trigonous" to those which are triangular in cross section, with obtuse angles, "triangular" to three-angled stems with acute angles and "triquetrous" to three-angled stems with acute angles and concave faces.

Population samples of ten specimens from each of three populations of *C. prolifer (Baijnath 745, 746, 763)*, two populations of *C. x turbatus (Baijnath 747, 752)* and one of *C. sensilis (Baijnath 794)* were collected and sectioned at base, midway and apex of culms. Sections, mounted in safranin-glycerin jelly, were illustrated using a Magnifax photographic enlarger and the results are summarised in Table 1.

TABLE 1

Variation in culm within populations of *C. prolifer*, *C. sensilis* and *C. turbatus*. The number of culms exhibiting each shape is given in parenthesis and the collector in each case was H. Baijnath. For details see Appendix 1.

SPECIES	Collector's Number	SHAPE		
		Base	Midway	Apex
Cyperus prolifer	763	terete (3) trigonous (9)	terete (2) trigonous (7) triangular (3)	terete (1) trigonous (6) triangular (5)
	745	terete (7) trigonous (8)	trigonous (12) triangular (3)	terete (1) trigonous (6) triangular (3) triquetrous (5)
	746	terete (8) trigonous (2)	terete (4) trigonous (6)	trigonous (10)
Cyperus x turbatus	752	terete (7) trigonous (3)	terete (5) trigonous (5)	trigonous (10)
	747	terete (9) trigonous (1)	terete (7) trigonous (3)	terete (2) trigonous (8)
Cyperus sensilis	794	terete (10)	terete (10)	terete (10)

In *C. prolifer* and *C. x turbatus*, considerable variation was evident. In each culm, there was a tendency for a gradual change from a terete or trigonous base to a triangular, triquetrous or trigonous apex, though in each taxon a few exceptions remained terete throughout.

C. sensilis exhibited less variation. The population sampled had uniformly terete culms. This is true of other populations studied, with the exception of one *(Baijnath 665)* in which triangular forms were noted.

It appears therefore that caution must be exercised in basing identifications solely on this character. On the whole, *C. sensilis* seems to be distinguished from the other two species by its uniformly terete culms, but this cannot be relied upon without reference to other features.

As culm shape is not always easily determinable from herbarium specimens, it is suggested that this feature would be of greater value in field recognition than in formal keys where it should only serve as an auxiliary characteristic.

(ii) *Inflorescence structure*

(a) Ray length and number

In the early descriptions of *C. prolifer*, much emphasis was placed on features of the inflorescence such as number of rays, ratio of lengths of rays within a head and average ray length.

These and other inflorescence features were compared using population samples of the following gatherings:

Baijnath 682, 710, 740, 743 (C. prolifer); Baijnath 752, (C. x turbatus); and *Baijnath 794* and *Ward 6804 (C. sensilis).*

Ray length was measured from the base to the first branch of each ray. Ray lengths were divided into classes of 1 cm units and the relative proportion of long and short rays assessed by comparing the distribution in these classes.

The results are summarised in Fig. 2.

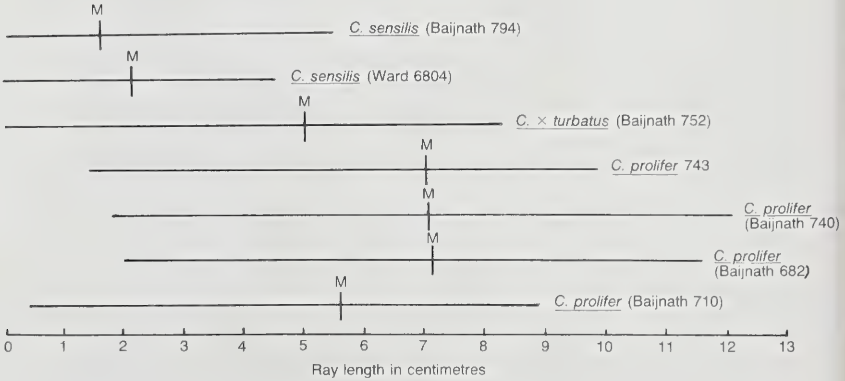


FIG. 2

Range of ray length and mean ray length (M) calculated from measurements of at least ten individuals from populations of *C. prolifer, C. × turbatus* and *C. sensilis.*

Ray length is, however, of little value in distinguishing these species (see Fig. 2).

The terms "equal rayed" or rays "subequal" are often applied to *C. prolifer* and Figure 3 represents an analysis of the relative lengths of rays in the three taxa being studied. The absence of very clear peaks and the presence of conspicuous numbers of rays both longer and shorter than the majority suggest that the term "equal rayed" is a misnomer and "subequal" seems scarcely justified as the range is wide.

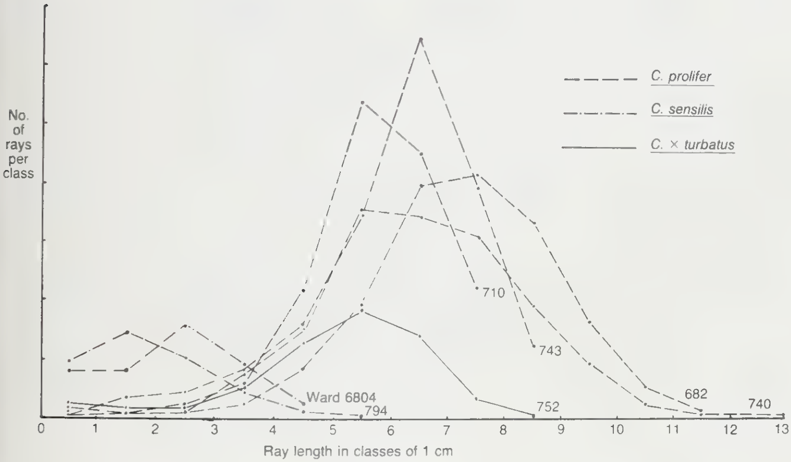


FIG. 3

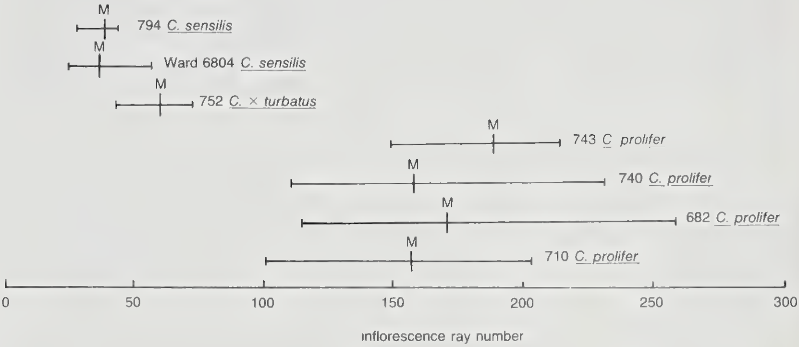
General frequency polygrams illustrating the range of inflorescence ray length within populations of *C. prolifer*, *C. sensilis* and *C.* × *turbatus*. Unless otherwise indicated, the collector's number refers to a Baijnath gathering.

Ray number was one of the features emphasised in early descriptions of *C. prolifer* which was variously described as having "50–100 rays", "numerossimis" or "100 or more rays". In the present study, a range from 101–259 with an average of 171 confirms that *C. prolifer* is indeed characterised by this feature and distinguished thereby from *C. x turbatus* and *C. sensilis* with fewer rays.

This study, therefore, confirms that ray number is a valid diagnostic criterion on which to distinguish *C.prolifer* from its allies, but does not support the emphasis on proportion of ray length as a diagnostic feature of any of the three species. *C. sensilis* and *C. x turbatus* are not reliably distinguishable on number of rays though *C. sensilis* appears, on average, to have fewer rays.

(b) Ray receptacle, umbel shape, spikelet number

Umbel silhouette has proved to be a useful field character and, if material is pressed with care, it is retained in herbarium specimens. The characteristic shapes are dependent on two features, ray number and ray receptacle shape.



Range of variation in ray number and mean ray number (M) calculated from populations of at least ten individuals of *C. prolifer, C. sensilis* and *C.* × *turbatus*. Unless otherwise indicated, the collector's number refers to a Baijnath gathering.

In *C. prolifer,* the numerous rays are borne on a spherical receptacle which results in an umbel which is almost spherical. When carefully pressed, these umbels flatten to a circle of rays with a conspicuous circle of tubular prophylls about the central axis.

In *C. sensilis*, with fewer rays on an awl-shaped receptacle, the umbel is a narrow sector of a sphere with the acute angle between extremes of the sector limits. *C. x turbatus* has an ovate receptacle with a filiform apex and the umbel is therefore a wider sector of a sphere. These and other features of the inflorescences are illustrated in Fig. 5.

In the bud stage, shape of bud and size of bracts can be used to distinguish these taxa. *C. prolifer* with its stout bud and long inferior bract averaging 4 cm and extending beyond the bud cluster is separated from *C. x turbatus* with a shorter inferior bract. *C. sensilis*, as could be expected from shape of ray receptacle, has a narrow elongated bud (see Fig. 5). Frequently the bract in *C. sensilis* remains upright even after the bud break, so that the umbel appears to be lateral.

Number of spikelets per ray varied among the species (see Fig. 5) and gave a useful visual aid to the identification of the species and combined with ray number in a scatter diagram serves to separate the taxa (see Fig. 6).

Thus, inflorescence features such as form of umbel, shape of receptacle, ray number and bract length provide useful diagnostic characters of value both in field recognition and identification of herbarium material.

CHEMICAL CHARACTERS

A one-dimensional survey of pigments of culm, inflorescence, and rhizome revealed that there was no variation within populations or between populations of

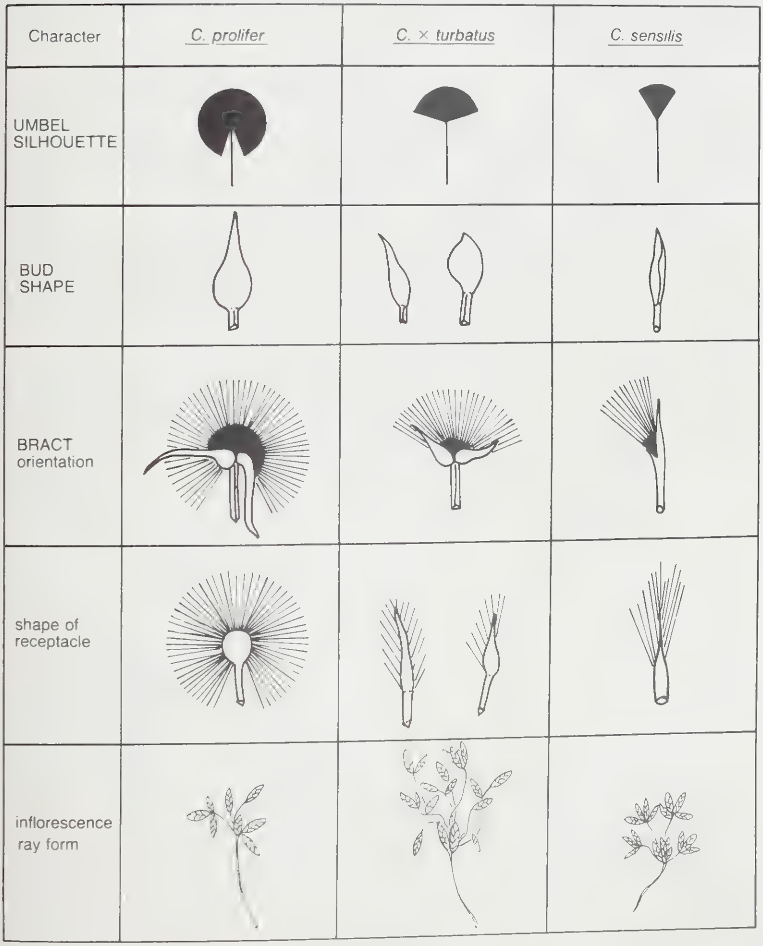


FIG. 5

Some diagnostic characters of *C. prolifer*, *C.* × *turbatus* and *C. sensilis*.

a single species. Culm extracts, however, revealed difference between species and a two dimensional study of the culm pigments was undertaken.

Direct extracts of culm samples were obtained by boiling material in ethanol over a waterbath for 5 mins. The extract was concentrated and spotted up on Whatman No. 1 chromatography paper (57 × 47 cm) prepared for descending chromatography. The chromatogram was developed in BAW (butanol-acetic acid-water) and 5% acetic acid.

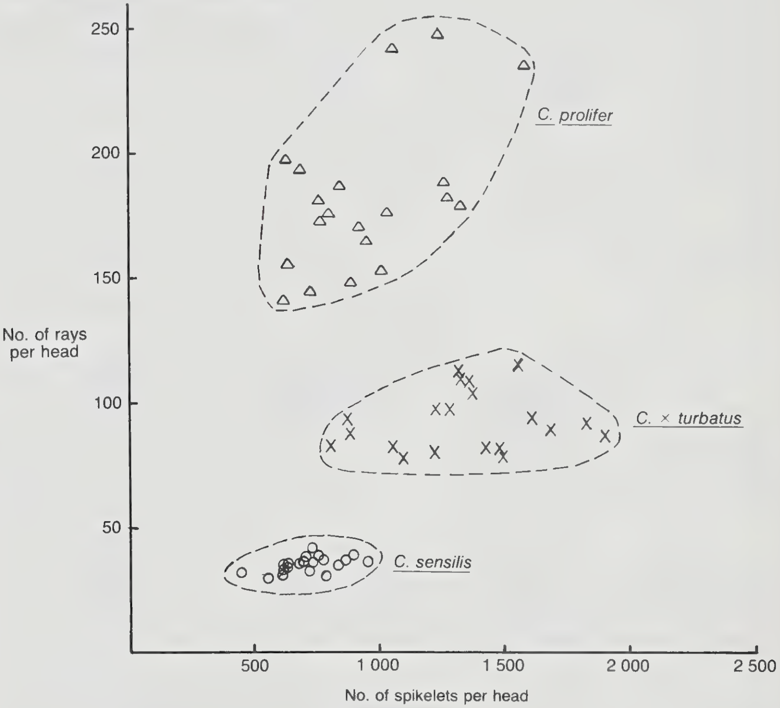
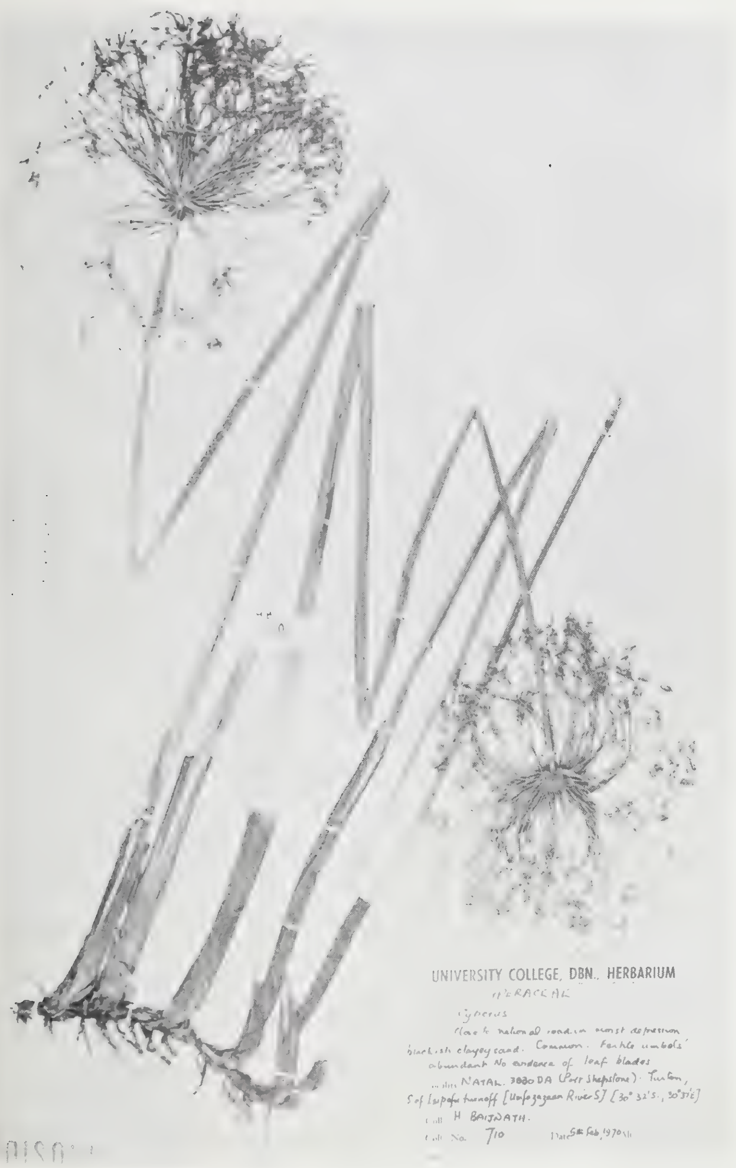


FIG. 6

Scatter diagram in which the number of inflorescence rays in heads of *Cyperus* species is contrasted with the number of spikelets per head.

Spots were located under ultra-violet light and colour changes on fuming with ammonia were recorded. The R_f in both solvents was calculated.

Thirty five spots were recorded and species-specific patterns were found. A large number of the spots were caffeic acid derivatives, but conspicuous flavone glycoside spots were present. The compounds were not identified but, on basis of colour and R_f, it is probable that tricin occurs in *C. prolifer* and that luteolin may



UNIVERSITY COLLEGE, DBN., HERBARIUM

CYPERACEAE

Cyperus

Close to national road in moist depression blackish clayey sand. Common. Fertile umbels abundant No evidence of leaf blades

Locality NATAL. 3030 DA (Port Shepstone). Turton, S of Ifafa turnoff [Umfazazaan River S] [30° 32'S., 30°37'E]

Coll. H BAIJNATH.

Coll. No. 710 Date 5th Feb, 1970

FIG. 7

An herbarium specimen of *C. prolifer* collected prior to burning. Leafless culms are present.

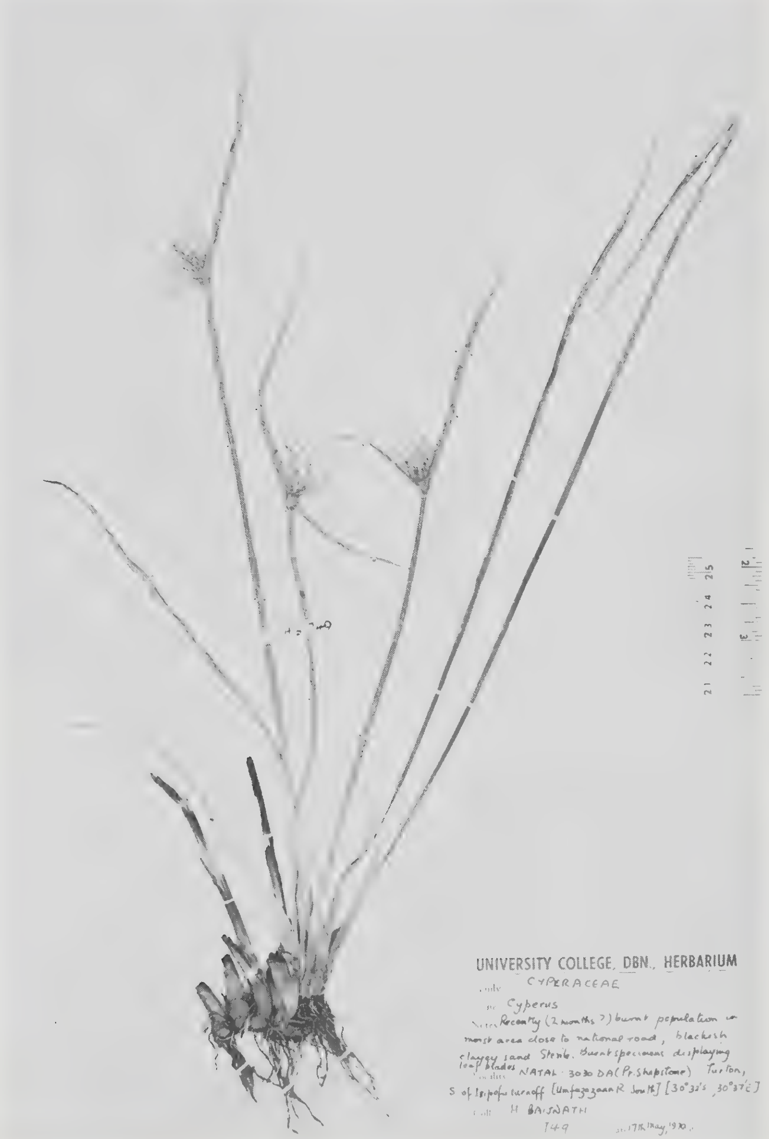

UNIVERSITY COLLEGE, DBN., HERBARIUM
CYPERACEAE
Cyperus
Recently (2 months ?) burnt population in moist area close to national road, blackish clayey sand Sterile. Burnt specimens displaying leaf blades
NATAL · 3030 DA (Pt. Shepstone) Turton, S of Isipofu turnoff [Umfazazana R South] [30°32'S, 30°37'E]
H BAISNATH
749
17th May, 1970.

Fig. 8
An herbarium specimen of *C. prolifer* from Merebank collected after burning. Leaf blades have been produced in the regenerating material.

be common to all three. Isolation and comparison with authentic compounds was outside the scope of this study.

Although there was a common core of compounds present in all three species, their patterns were distinctive with *C. prolifer* and *C. sensilis* possessing some unique spots. The basic similarity in 'fingerprint' patterns may reflect generic characteristics and studies of other species is necessary. Nevertheless, the patterns were sufficiently distinct to suggest that the three taxa were separate entities.

REACTION TO DENUDATION

Although the three species under discussion are generally leafless, as are all members of the section *Textiles*, occasionally, during the course of this investigation, specimens bearing short laminae in addition to the normal leaf sheath were collected. These leafy forms were found in populations which were regenerating after fire and Figs. 7 and 8 show successive collections of *C. prolifer* from Merebank before and after fire.

After fire, the regenerating plants were stunted but prominent bracts and leaf blades were visible. Similar reactions in grasses have long been utilised in research on pasturelands, to increase nutritive properties (Smith and Young, 1959), succulence (Vogl, 1965) and biomass (Hadley and Kieckhefer, 1963). There is also some debate as to whether mowing would have similar effects (Wright, 1969; Knight 1970). Little comment on this phenomenon in sedges has been recorded, however, and an experiment in controlled burning and mowing of *Cyperus* was carried out during the course of this study.

Two experimental areas at Merebank and at Clairwood Racecourse proved suitable for experiments on all three species.

Representative herbarium specimens of each species were collected from each site. The plots were divided into three areas. Plot 1 was burnt, with the addition of dry vegetation to simulate a veldfire. Plot 2 was cut to a height of 2–3 cm and plot 3 left as the control.

Progress was recorded at weekly intervals for 10 weeks by photographs, notes and collections.

Regeneration of *C. prolifer* involved the development of leaf blades, increase in numbers of culms, but decrease in height and diameter of culms, reduction in number and length of inflorescence rays, but increase in length of bracts.

C. sensilis, on regeneration, flowered and produced a few minute leaf blades while *C. x turbatus* exhibited only an increase in flowering.

These responses suggest that under stress, survival of *C. prolifer* is likely to be through rapid vegetative growth to promote maximum photosynthetic tissue to provide adequate reserves in rhizomes and latent vegetative buds, while in the other two species response to stress is the production of flowers.

ANATOMY

The three species under consideration were not included in the recent survey of anatomy of *Cyperus* L. (Metcalfe, 1971) and a detailed anatomical study was undertaken.

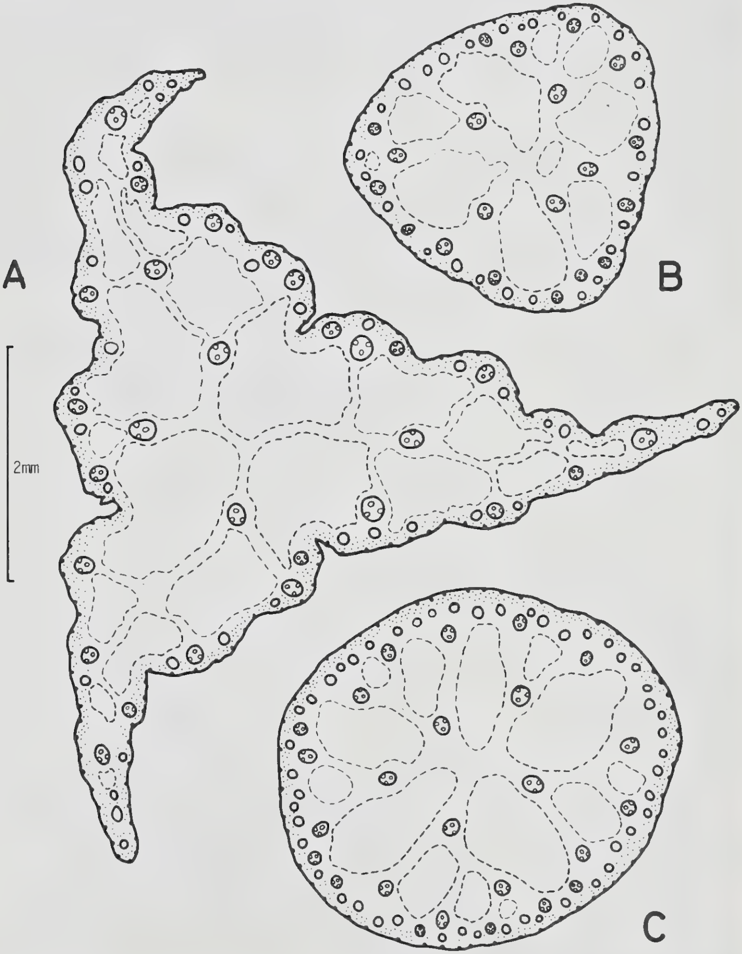


FIG. 9

Plan of the distribution of tissues in transverse sections of culms of *C. prolifer* (A), *C. x turbatus* (B) and *C. sensilis* (C). Dotted lines indicate boundaries of air spaces and stippled area represents the chlorenchyma.

Roots, rhizomes and culm bases showed little of diagnostic importance but, as predicted by Metcalfe *(l.c.)* bracts and culms were more useful.

Mid-portions of bracts and culms were dehydrated and embedded in wax following standard procedures, and transverse sections prepared with a Leitz sledge microtome.

In transverse sections the shapes of the culm were often characteristic of the species (see Fig. 9) but as we have indicated, this feature is not entirely reliable.

Vascular bundles are distributed in a peripheral chlorenchymatous zone with a few present at the interstices of the translucent mesh of stellate parenchyma which composed the major part of the section.

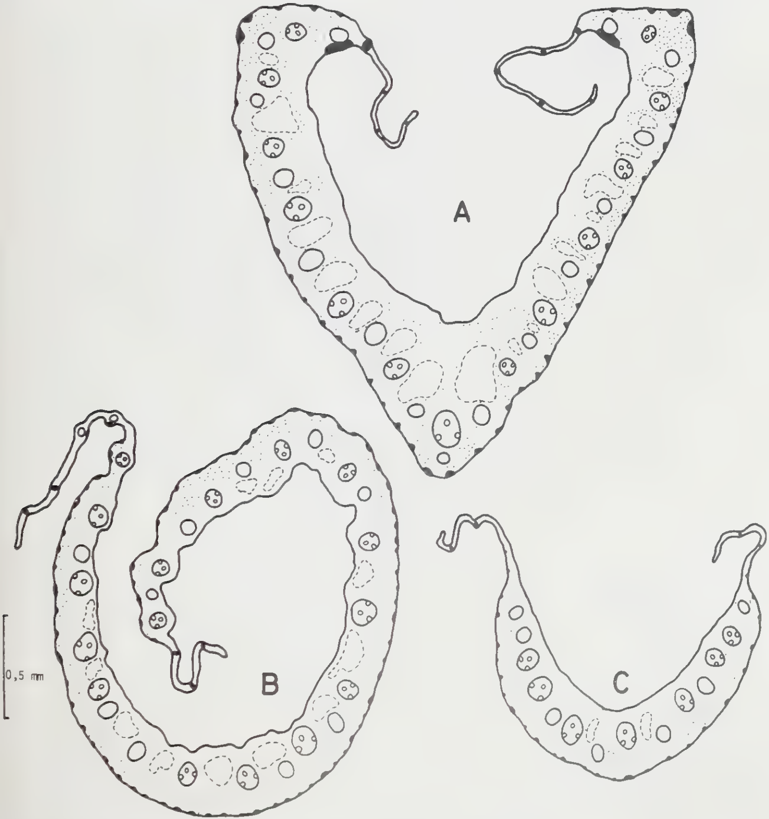


FIG. 10

Plan of distribution of tissues in transverse sections of involucral bracts of *C. prolifer* (A), *C.* × *turbatus* (B) and *C. sensilis* (C).

A heavily cuticularised epidermis is present in all three species, but *C. prolifer* is distinctive as epidermal papillae are frequent here. Papillae are occasionally found in *C. x turbatus* but absent in *C. sensilis*. Metcalfe *(l.c.)* noted that epidermal papillae are uncommon in *Cyperus* and their presence here may be of

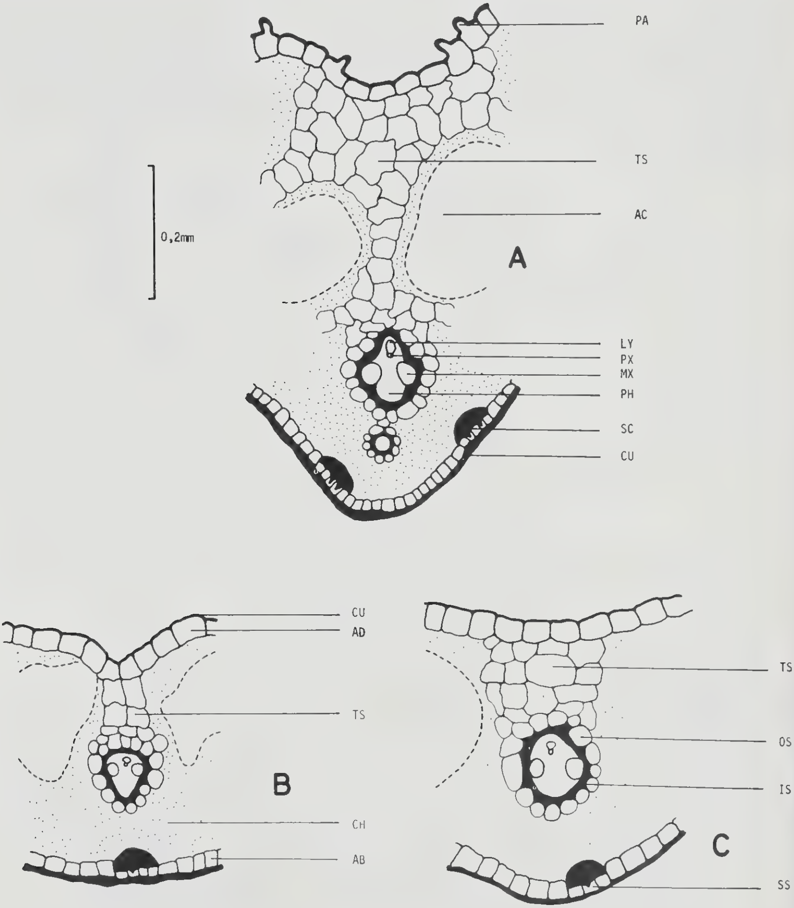


FIG. 11
Semi-detail of the central portion of the involucral bracts of *C. prolifer* (A), *C.* × *turbatus* (B) and *C. sensilis* (C). (AB- abaxial epidermis: AC- air cavity: AD- adaxial epidermis: CH- chlorenchyma: CU- cuticle: LY- protoxylem cavity: MX- metaxylem: OS- outer sheath: PA- papilla: PH- phloem: PX- protoxylem: SC- sclerenchyma: TS- translucent hypodermis.)

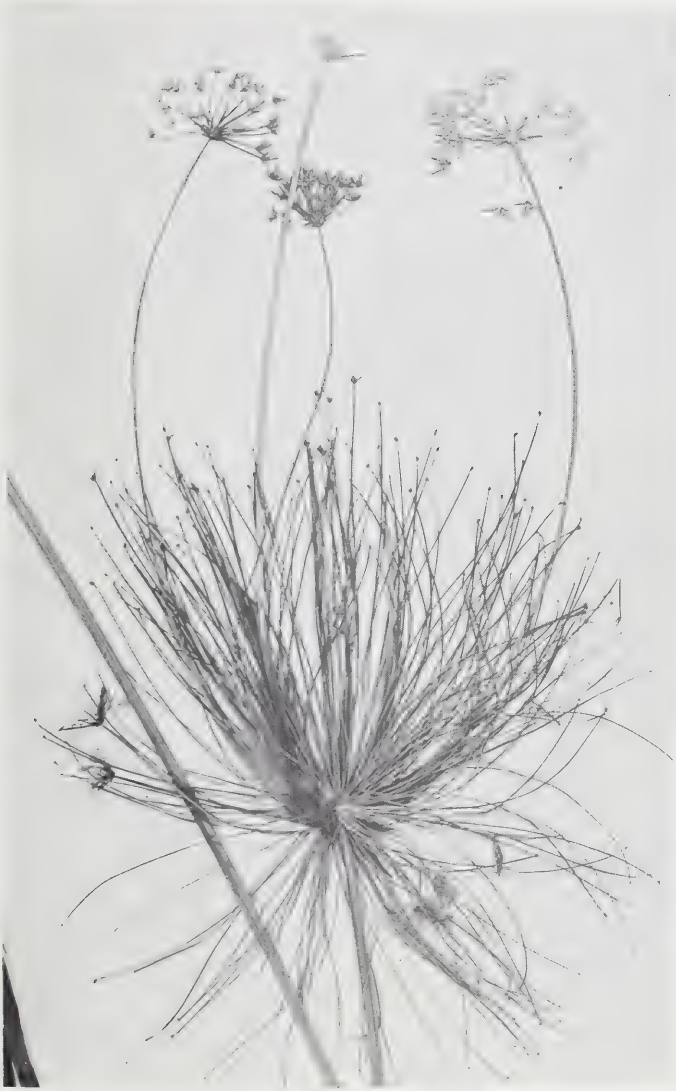


FIG. 12

Vegetative proliferations arising from the axils of involucral bracts in *C. prolifer.*

importance. Further examples within the genus should be studied to assess the taxonomic value of such a feature. Conical silica bodies characteristic of *Cyperus* are features of the epidermis.

The peripheral chlorenchyma is interrupted by regular clusters of sclerenchyma strands and occasional tanniniferous cells are present. Second and third order vascular bundles are found in the peripheral chlorenchyma, and first order bundles at the interstices of the ground aerenchyma. An inner sclerenchyma and outer chlorenchyma sheath enclosed each bundle. The ground tissue consists of a reticulum of stellate parenchyma. In it are cavities formed by the disintegration cells. Stellate parenchyma had been reported in the genus (Fahn, 1974).

Transverse sections of the bracts have distinctive shapes (see Fig. 10) and the median bundle also reveals some notable distinguishing features (see Fig. 11).

Bracts of *C. prolifer* possess two median bundles, a larger first order and a smaller third order bundle both enclosed in conspicuous inner sclerenchyma and outer parenchyma sheaths. In addition, paired sclerenchyma strands are situated abaxially at the mid vein of the bract. *C. prolifer* has epidermal papillae on the bracts.

C. x turbatus and *C. sensilis* have single median bundles and sclerenchyma strands and are without papillae.

Of added value are the mid axial hypodermal layers of large parenchymatous translucent cells. In transverse sections, this layer is T-shaped in *C. prolifer*, square in *C. x turbatus* and almost circular in *C. sensilis*.

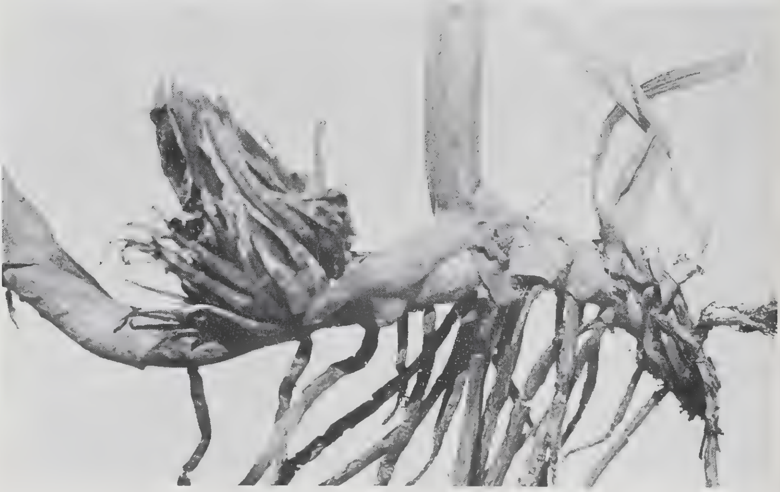


FIG. 13
Bulbils produced at the base of the culm in *C. prolifer*.

Although in many respects, these species are anatomically similar, differences in bract shape vascular arrangement, translucent tissue and epidermis may be used to distinguish between them.

VEGETATIVE REPRODUCTION

Although a wider study of vegetative reproduction in *Cyperus* is anticipated, it is pertinent to comment here on the variety of forms of vegetative reproduction encountered in this group of species.

C. prolifer, as its epithet implies, frequently exhibits vegetative proliferations. These commonly arise in the axiles of involucral bracts (see Fig. 12), from the apices of inflorescence rays, by modifications of spikelets and by means of bulbils (Fig. 13) produced at or near culm bases.

C. x turbatus has been seen to proliferate like *C. prolifer* and also exhibits rapid growth of slender culms under conditions of stagnation. *C. sensilis*, though much less active in this respect does occasionally show a reaction to stagnation of the same form as in *C. x turbatus* (Fig. 14).

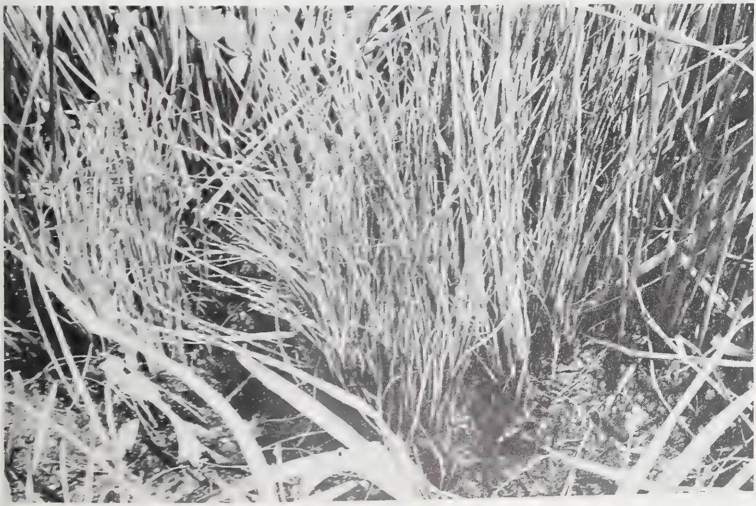


FIG. 14

Proliferation of fine 'Grass-like' culms of *C. × turbatus* in response to stagnant conditions.

CONCLUSION

C. prolifer, *C. x turbatus* and *C. sensilis* appear to be discrete with specific ecological preferences. They are distinguishable on morphological features of inflorescence form as well as on anatomical and chemical grounds. Traditional diagnostic characteristics of culm shape have been found to be less valid than features of inflorescence form and keys to the identification of these taxa are provided below. The first is based on features which could be observed in field or herbarium specimens, the second chiefly on ecological preferences.

KEY

Rays 101–259 in umbel, forming almost spherical inflorescence; inferior involucral bracts usually 3 cm long, V-shaped in transverse section, with two vascular bundles and an hypodermis 9–12 cells deep in the mid vein . . . .**C. prolifer** Lam.

Rays 25–73, in a compact raceme forming a narrow sector of a sphere; inferior involucral bract usually<3 cm long, variable, but not V-shaped in transverse sections, with one vascular bundle and hypodermis 2–5 cells deep in the mid vein.

Rays 42–73, forming obtuse angle at culm apex; ray receptacle ovoid with extended filiform apex; inferior involucral bract c.2 cm long; papillae sometimes present on culm epidermis . . . .**C. x turbatus** Baijnath

Rays 25–57, forming an acute angle at culm apex; ray receptacle filiform; inferior involucral bract c. 1 cm long; invariably without papillae . . . .**C. sensilis** Baijnath

FIELD KEY

Vegetative reproduction occasionally by means of rapid proliferation of fine culms (''grass-like'' growth), not associated with inflorescence or spikelet; sterile rays never extended; inflorescence receptacle filiform . . . .**C. sensilis** Baijnath

Vegetative reproduction by proliferations associated both with vegetative parts and inflorescence and spikelet; sterile and fertile rays extended; inflorescence receptacle ovoid to spherical.

Reactions to stagnating conditions by rapid proliferation of fine culms (''grass-like'' growth); bulbils absent; populations dormant in winter; inflorescence receptacle ovoid with filiform point . . . .**C. x turbatus** Baijnath

Intolerant of stagnating conditions, grasslike growth not exhibited; bulbils common; populations active throughout year; inflorescence receptacle spherical **C. prolifer** Lam.

ACKNOWLEDGEMENTS

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Appendix 1

Citations of specimens used in studies of morphological, anatomical and chemical characters of *C. prolifer* Lam., *C. sensilis* Baijnath and *C. x turbatus* Baijnath.

C. prolifer

Baijnath

682 3030 BC, (Port Shepstone): Umzinto Park Rynie Road, *II*.1970.

710 3030 DA, (Port Shepstone): Turton Umfazazaan River South (S. of Isipofu turn-off), *II*. 1970.

740 3030 BC, (Port Shepstone): Park Rynie Roadside, *IV*. 1970.

743 2930 DD, (Pietermaritzburg): Merebank S.W., *IV*. 1970.

745 3030 CD, (Port Shepstone): Shelley Beach, *V*. 1970.

746 3030 (Port Shepstone): Shelley Beach, *V*. 1970.

763 2930 DD, (Pietermaritzburg): Clairwood Race Course, *IX*. 70.

C. sensilis

Baijnath

665 2832 AD, (Mtubatuba): St. Lucia Park, *XI*. 1969. *794* 2930 DD, (Pietermaritzburg): Happy Valley Bird Sanctuary. 1970.

Ward 6804 2832 AB, (Mtubatuba): Makhakhatana, *XI* 1969.

C. x turbatus

Baijnath

747 3030 CD, (Port Shepstone): Shelley Beach, *V*. 1970.

752 3030 BC, (Port Shepstone); Umdoni Park. 1970.

Jl S. Afr. Bot. 43 (1): 41–56 (1977)

THE SUBTERRANEAN INTERMEDIARY ORGANS OF *DIOSCOREA COTINIFOLIA* KUNTH: 1. THE GERMINATION, DEVELOPMENT, MORPHOLOGY AND VEGETATIVE REPRODUCTION OF THE TUBEROUS SWOLLEN AND CYLINDRICAL INTERMEDIARY ORGANS.

I. von Teichman und Logischen, P. J. Robbertse and H. P. van der Schijff
(Department of Botany, University of Pretoria)

Abstract

Germination and morphological studies were carried out on several Transvaal *Dioscorea* species. It is concluded that since (1) the number of vascular traces entering the petiole of the cotyledon differs from that entering the first vegetative leaf and (2) the venation of the cotyledonary lamina also differs from that of the first leaf, the embryo can have only one cotyledon. *Dioscorea cotinifolia* has a specialised tuber system consisting of a crown and several tubers borne by long, cylindrical organs. All these organs, which originate directly or indirectly by tuberisation and/or branching from the hypocotyl, are regarded as intermediary organs. These intermediary organs have characteristics typical of both the shoot and the root. They develop from a deep-seated lateral meristem found neither in the shoots nor the roots of *Dioscorea*. The intermediary organs initially serve as absorptive organs and bear adventitious roots. The main functions of the intermediary organs are those of storage and vegetative reproduction.

Uittreksel

DIE ONDERGRONDSE INTERMEDIÊRE ORGANE VAN *DIOSCOREA COTINIFOLIA* KUNTH. DIE ONTKIEMING, ONTWIKKELING, MORFOLOGIE EN VEGETATIEWE VOORTPLANTING VAN DIE KNOL, KNOLVORMIGE EN SILINDRIESE INTERMEDIÊREORGANE.

Die saadontkieming en morfologie van verskeie Transvaalse *Dioscorea*-soorte is ondersoek. Aangesien die aantal vaatstringe wat die blaarsteel van die saadlob binnegaan verskil van dié wat die eerste vegetatiewe blaar binnegaan en aangesien die bearing van die saadloblamina verskil van dié van die eerste blaar, is afgelei dat die embrio oor 'n enkele saadlob beskik. *Dioscorea cotinifolia* het 'n gespesialiseerde knolsisteem, bestaande uit die kroon en verskeie knolle wat aan lang silindriese organe gedra word. Al hierdie organe, wat direk of indirek deur knolvorming en/of vertakking uit die hipokotiel ontstaan, word as intermediêre organe beskou. Hierdie intermediêre organe besit stingel- sowel as wortelkenmerke. Hulle ontstaan uit 'n diepgeleë laterale meristeem wat nòg in stingels nòg in wortels van *Dioscorea* aangetref word. Die intermediêre organe dien aanvanklik as absorpsieorgane. Hulle dra bywortels, help om die plant te anker en vervul veral die funksie van stoor en vegetatiewe voortplanting.

1 Introduction

The Dioscoreaceae was first recognised as a family in 1819 (Burkill, 1960) and, according to Bucherer (1889), Dutrochet as early as 1835 commented on the

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Accepted for publication 28th July, 1976.

embryonic cotyledons and the peculiar growth of the tuber of *Tamus communis*, a genus closely related to *Dioscorea*. It was De Barry (1884) who distinguished three types of storage organs in this family: (1) tuberous swollen roots; (2) rhizomes; and (3) leafless tubers resulting from the swelling of the first epicotyledonary internode of the seedling. He stated, however, that tubers "require more exact investigation in all points". Goebel (1905), probably following the opinion of earlier workers including Queva (1894) and Leclerc du Sablon (1902) as quoted by Burkill (1960), described some Dioscoreaceae tubers as "Organe, die ohne aus einer Umbildung von Wurzeln oder Sprossen hervorgegangen zu sein, in ihren Eigenschaften teils den Sprossen, teils den Wurzeln nahestehen".

Burkill (1960) himself considered the tuber to be "a contraction from the rhizome", i.e. a stem structure.

Koch and Bruhn (1962) regarded the tuber of *D. floribunda* as a thickening of the hypocotyl. Martin and Ortiz (1963) although confirming many of Koch and Bruhn's observations were of the opinion that the tubers of *D. floribunda* and *D. spiculiflora* comprised "much modified stem tissue, thus being a relic of the ancestral rhizome". Troll (1967), apparently basing his opinion only on the observations of other workers, rejected Goebel's opinion, maintaining that it could be demonstrated incontestably that the tubers of *Tamus communis, Dioscorea sinuata* and *Testudinaria elephantipes* were shoot tubers.

Ayensu (1972) concluded that further studies were necessary to understand the true morphological nature of the storage organs. He also reviewed the "controversy in the literature concerning the number of cotyledons". Two recent publications showed that the number of cotyledons is still in dispute (Sharma, 1974; Sadik and Okereke, 1975).

The results of a detailed morphological study of the seven *Dioscorea* species occurring in the Transvaal (Republic of South Africa), which included a germination study of four species, have already been partly described (von Teichman und Logischen, 1973; von Teichman und Logischen, *et al.*, 1975). This paper reports on the seed germination, development and morphology of the tuber system and vegetative reproduction of *D. cotinifolia*. An account of the anatomy of the aerial shoot and the root in comparison with the tuber system of *D. cotinifolia* is in preparation.

2 MATERIAL AND METHODS

2.1 *General*

Observations were made from specimens in the National Herbarium in Pretoria, the Moss Herbarium of the University of the Witwatersrand, Johannesburg, the Herbarium of the University of Pretoria, and from personal records.

Material, involving the removal of one or more entire plants, was collected at 20 different localities in the Transvaal. At least one herbarium specimen was prepared from every plant while some tubers were planted in the garden of the University of Pretoria and others preserved in formalin-acetic acid-alcohol (FAA) together with remainders of the shoots, after material had been reserved for anatomical studies.

2.2 *Germination*

After preliminary germination tests the following optimal treatment was used: seeds were soaked in tap water for 40 to 48 h, surface-sterilised for 1 min with undiluted commercial bleach and rinsed five times with sterile tap water. The seeds were either placed in sterilised vermiculite in pots or on sterilised filter paper in petri dishes. Sterilised tap water was applied.

Seeds were germinated in the dark at 27° C in a room with a relative humidity (R.H.) of 70%. After the radicle and first leaf had appeared the seedlings on the filter paper were transferred to vermiculite. All seedlings were kept at 27° C and 70% R.H. under constant light for one month and a nutrient solution (see APPENDIX), was applied three times every week. Seedlings were then transferred to sandy soil and kept in a glasshouse for two months at temperatures and relative humidities with average maxima and minima of 35 and 18° C and 96 and 70%, respectively.

Seedlings were cleared in 85% lactic acid at 60° C, washed with distilled water and stained in 0,1% basic fuchsin (aqueous) for three hours; excess stain was removed with distilled water followed by 70% ethanol. The cleared seedlings were then transferred back to lactic acid and examined and dissected in glycerine.

3 OBSERVATIONS AND DISCUSSION

As Archibald (1967) published a detailed morphological account on *D. cotinifolia* from the Cape Province west of East London, only a few additional remarks are necessary. In the Transvaal *D. cotinifolia* commences flowering in October, the trilocular capsules starting to ripen in about January. The distally winged seeds (Fig. 1A) contain a 1,16 to 1,25 mm long embryo which lies loose in the slit of the predominantly proteinaceous endosperm. Dissection of seeds was easy since the embryo is situated near the raphe, opposite a small dark patch in the adjoining wing (Fig. 1B). This patch appears darker because of the heavy pigmentation of the two inner layers of the wing. In FAA-preserved and -soaked seeds the raphe containing the vascular tissue could be pulled off together with a little bit of the surrounding tissue. The position of the embryo in the seed is constant in all the species within a section (Fig. 2, 3 and 4 in von Teichman und Logischen *et al.*, 1975).

The cotyledon forms a one-lobed (Fig. 1C) or two-lobed, very inconspicuous flap (Fig. 1D) which conceals the plumule partly or wholly. When this cotyledonary sheath is removed, the first vegetative leaf primordium can be distinguished. The growing point of the stem can be seen only in longitudinal sections (Fig. 1E).

The embryos of the seven species studied show much resemblance to one another and to that of *D. bonariensis* illustrated by Beccari (1870). Beccari, however, interpreted part of the cotyledonary sheath as the second rudimentary cotyledon. On the other hand the embryo of *D. villosa* (Smith, 1916) differs in having no cotyledonary sheath. The embryos described by Rao (1953), Lawton and Lawton (1967), Sadik and Okereke (1975) and others, also resemble that of *D. cotinifolia.*

3.1 *Germination*

Germination studies were done on *D. dregeana, D. quartiniana* and *D. sylvatica* in addition to those on *D. cotinifolia.* Only a few interesting differences are mentioned here.

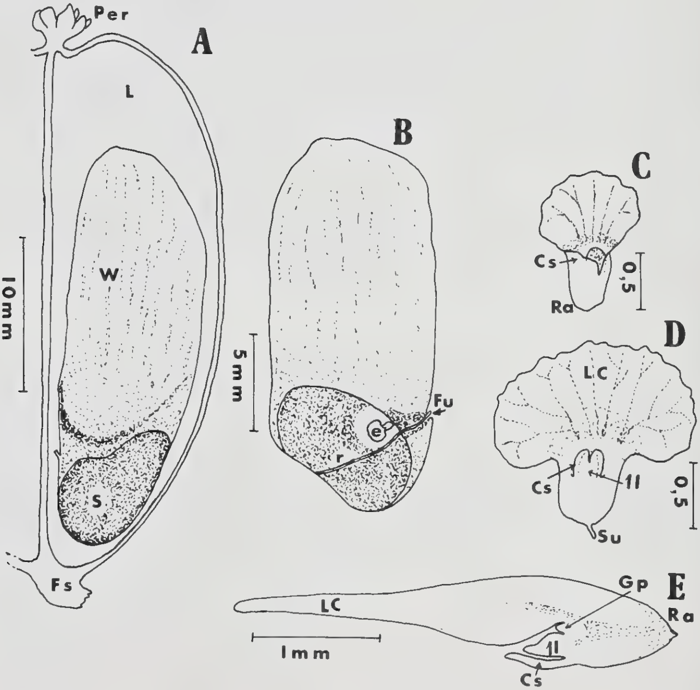

FIG. 1.

Morphology of the seed and embryo of *D. cotinifolia.* A: Position of seed in the locule; B: position of embryo in the seed; C & D: Embryos; E: ls of embryo. *Cs* cotyledon sheath; *e* embryo; *Fs* fruit stalk; *Fu* funicle; *Gp* growing point of stem; *L* locule; *LC* lamina of cotyledon; *1l* first vegetative leaf; *Per* perianth; *Ra* radicle; *r* raphe; *S* seed; *Su* suspensor; *W* seed wing.

The seeds were considered to have germinated once the radicle had emerged (Fig. 3A). Germination of the fully ripened seeds of *D. cotinifolia* took place after an average of 11 days, the range being 9 to 12 days. About four days later the first vegetative leaf appeared still surrounded by the delicate sheath (Fig. 2B and 3B). In *D. sylvatica* the cotyledonary sheath becomes tube-like and has a distinct slit through which the first leaf emerges. This is similar to seedlings of *D. elephantipes*, a closely related species (Sparshott, 1935). The seedlings of *D. cotinifolia* illustrated in Fig. 3A and 3B were cleared, dissected and the complex course of the vascular tissue reconstructed (Fig. 2A and 2B). A large number of idioblasts containing mucilage and raphide bundles are present. On entering the cotyledon stalk (i.e. petiole), the six basal veins of the cotyledon lamina unite intricately (Fig. 2A). The two vascular traces from the cotyledon stalk (Fig. 2B:VTC) unite shortly before they enter the epicotyl-hypocotyl region while a single element (tracheid) branches off and re-unites. The origin of the three vascular traces of the first vegetative leaf (Fig. 2B:VT1l) is clearly distinguishable. A single element branches off to join one of the cotyledonary traces (VTC). Two lateral root primordia are already developed. The first leaf is protected by the cotyledonary sheath.

Similarly, the primordium of the second leaf lies protected in the leaf sheath of the first (Fig. 4A). This is typical of monocotyledonous leaves. A large number of club-shaped multicellular glandular trichomes occur on the first leaf (Fig. 2B). In Fig. 2B the idioblasts were omitted from the drawing for the sake of clarity.

The lamina of the cotyledon which serves as an haustorium enlarges (Fig. 3C) until it occupies the whole slit in the endosperm. The lamina of the first leaf which unfolds about 16 days after germination is the largest of all the leaves on the primary stem. It is as large as or larger than the mature leaves of the parent plant. The venation of the first leaf (Fig. 3D) resembles that of mature leaves which also have seven main veins at the base. The veins of the cotyledonary lamina (Figs. 2 and 3C) on the other hand fuse to form three veins at the base.

In their review, Weber and Troll (1969) stated that the results of Lawton and Lawton (1967) deserved re-examination and that their illustration of the "second cotyledon" as a small "hump" in the embryo indicated that it could in fact be regarded as the first vegetative leaf. Recently Sharma (1974), apparently without much personal investigation, adopted the idea of Lawton and Lawton. Since the venation of the cotyledonary lamina differs from that of the first vegetative leaf and since there is a difference in the number of vascular traces in the petioles of these leaves, it was concluded that there is only one cotyledon in *Dioscorea*. This confirms the ideas of Sparshott (1935), whose serial transverse and longitudinal sections indicate *inter alia* the presence of a very short epicotyl. Lawton and Lawton's (1967) report on the presence of two cotyledons in *Dioscorea*, however, ignored the results of Sparshott.

The very first sign of a tuber, i.e. a swelling of the hypocotyl, appears

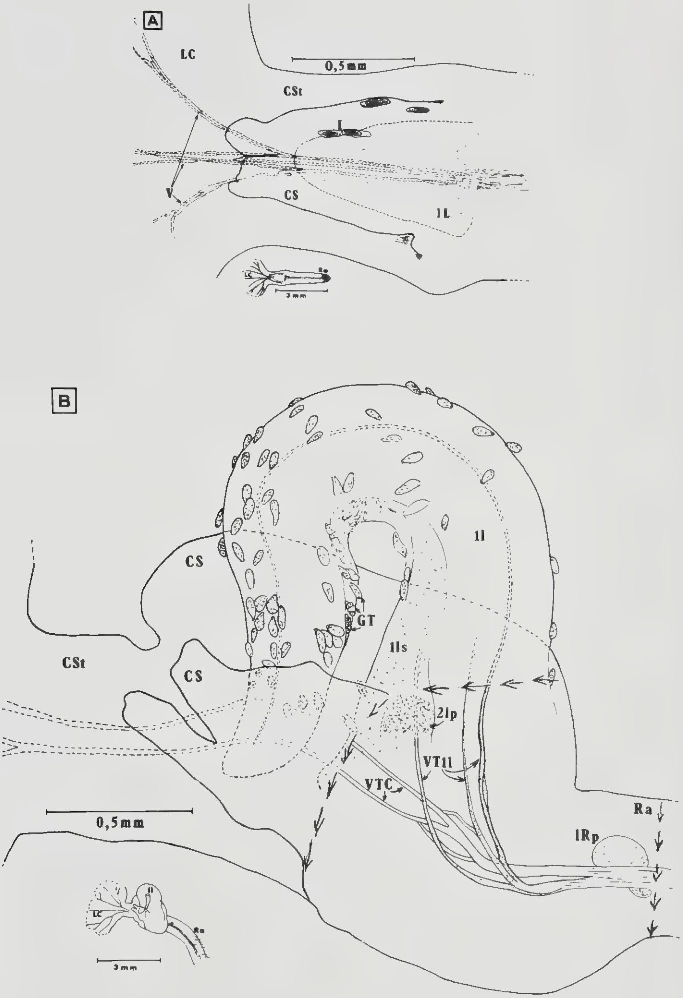

FIG. 2.

Young seedlings of *D. cotinifolia*, cleared and dissected. A: The seedling shown in Fig. 3A; B: The seedling shown in Fig. 3B. *CS* cotyledon sheath; *CSt* cotyledon stalk; *GT* glandular trichomes; *I* idioblasts; *LC* cotyledon lamina; *1L/1l* first vegetative leaf; *2lp* second leaf primordium; *1ls* first vegetative leaf sheath; *lRp* lateral root primordium; *Ra* radicle; *VTC* vascular traces of cotyledon; *VT1l* vascular traces of first vegetative leaf; *V* veins. In the region demarcated by arrows the uppermost tissues were removed.

simultaneously with the expansion of the first leaf lamina (Fig. 3C). Before or as the second leaf appears, approximately 26 days after germination, the tuber is usually easily distinguishable directly below the first leaf base (Fig. 3E, F, G and H). The tuber therefore originates in the hypocotyl, confirming the reports of many other workers.

The main root is pushed to one side by the enlarging tuber. Lateral and adventitious roots develop from the main root and young tuber, respectively, at a very early stage (Figs. 3C and 3E).

The growing point of the primary stem can be distinguished at the base of the second leaf sheath. In *D. cotinifolia* the stem developed about 37 days after germination. In *D. sylvatica, D. quartiniana* and *D. dregeana* the first stems developed 34, 40 and 74 days after germination respectively.

Dioscorea quartiniana is the South African species with the widest distribution throughout Africa, i.e. northwards in the eastern parts up to Ethiopia and in the west from the northern parts of South West Africa northwards to Senegal (Burkill, 1939). Like other tropical species (Martin and Ortiz, 1963; Sarwa, 1971) the majority of *D. quartiniana* seedlings developed only one leaf, while the others developed two leaves and a short stem within the first growing season as in the other three species. When the stem first appeared, it could have been mistaken for a third leaf, that is until a swelling appeared in the middle of its apparent petiole. This swelling is the node bearing the third leaf, while the growing point is hidden in the sheath of that leaf.

Most of the seedlings of the four species, i.e. 69 out of 105 produced two basal leaves before the emergence of the rest of the primary shoot. Twenty-three seedlings developed only one basal leaf on the stem, the second leaf being reduced to a small bract. Each of the remaining seedlings developed two leaves and two stems, the second stem possibly developing from the axillary bud of one of these leaves. These observations confirmed those made on *D. elephantipes* in which the first two leaves are the most basal leaves of the primary shoot (Sparshott, 1935). This seems acceptable because although leaves of adult plants are arranged alternately, opposite leaves are occasionally found at some of the basal nodes. The stem of the seedling usually dies off completely in the winter. During the next growing season the new stem develops from one of the hidden axillary buds of the basal leaves.

3.2 *Development and morphology of the intermediary organs*

Although initially all the tubers from the same lot of seedlings looked similar (Fig. 3F, G and H), a remarkable difference in shape could be distinguished once the seedlings were two months old.

In the one lot for example, 20 of the 30 seedlings had pear-shaped tubers (Fig. 4B), while the remaining seedlings had distinctly elongated cylindrical organs (Fig. 4C). In some seedlings the developing cylindrical organ tuberised entirely,

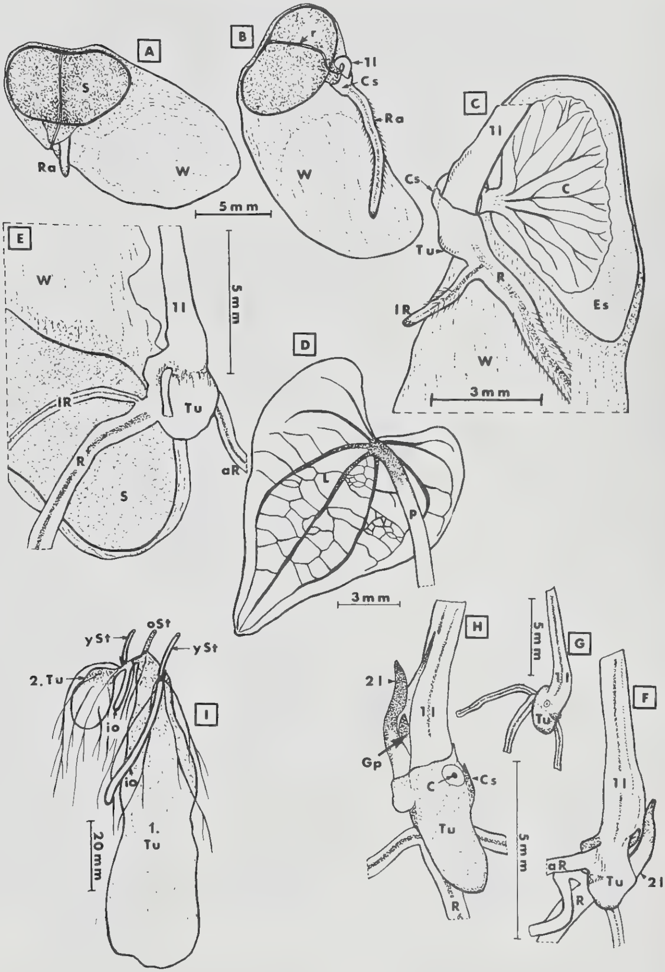

Fig. 3.

Tuber development of *D. cotinifolia*. A: radicle appears; B: first leaf appears; C: seed is dissected to show the cotyledon lamina; D: lamina of first leaf; E: displacement of main root by tuber growth; F, G, H: very young tubers; I: tuber of seedling at beginning of second season. *aR* adventitious root; *C* cotyledon; *Cs* cotyledonary sheath; *Es* endosperm; *Gp* growing point of stem; *io* intermediary organ (cylindrical); *lR* lateral root; *1l* first vegetative leaf; *2l* second leaf; *L* lamina; *oSt* old stem; *P* petiole; *Ra* radicle; *R* main root; *r* raphe; *S* seed testa; *Tu* tuber; *W* seed wing; *ySt* young stem.

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thus also becoming pear-shaped. In other seedlings only the distal part tuberised while the proximal part produced a lateral branch which also formed a tuber. In any of these seedlings branches with swollen tips could also develop from the tuber crown, i.e. the proximal part of the tuber which gives rise to a stem each year. Seedlings found in the field (Fig. 4D) confirmed that these two types of tuber development were natural and not induced by experimental conditions. Our results

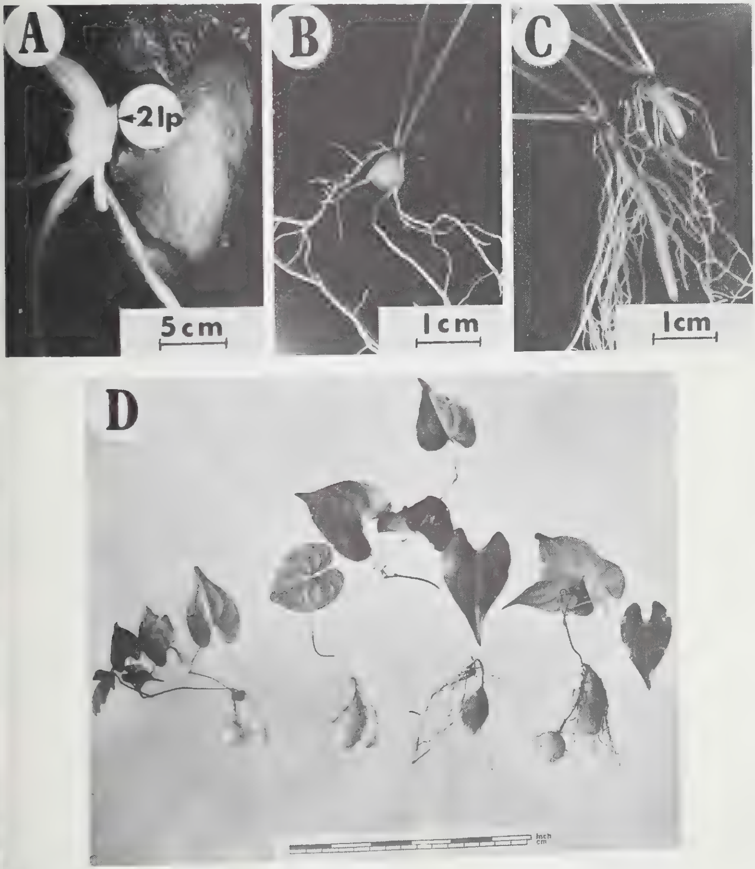

FIG. 4.

Developing tubers of *D. cotinifolia* seedlings. A: second leaf primordium (2lp) developing; B: seedling with a pear-shaped tuber and stem with one basal leaf; C: seedling with first cylindrical intermediary organ before tuberisation, the stem having two basal leaves; D: seedlings collected in the field illustrating tuberisation of the intermediary organs.

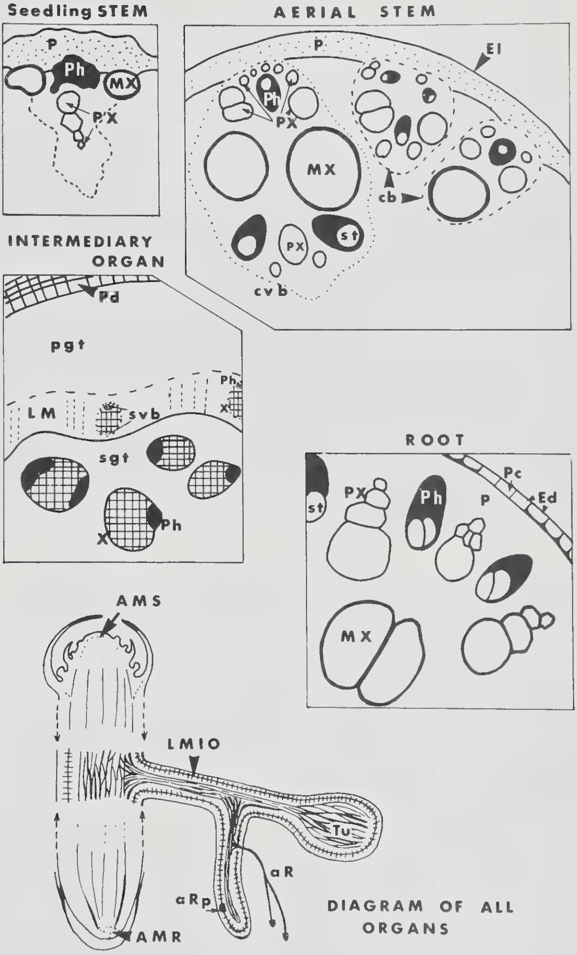

FIG. 5.

A diagrammatic representation of the position and anatomy of the different organs. *AMS* apical meristem of shoot; *AMR* apical meristem of root; *aR* adventitious root; *aRp* adventitious root primordium; *cb* common vascular bundle; *cvb* cauline vascular bundle; *Ed* endodermis; *El* endodermoid layer; *LM*/*LMIO* deep-seated lateral meristem of intermediary organ; *MX* metaxylem; *P* pericycle; *Pc* passage cell; *Pd* periderm; *pgt* parenchymatous or peripheral ground tissue; *Ph* phloem; *PX* protoxylem; *sgt* sclerenchymatous and/or central ground tissue; *st* sieve tube; *svb* secondary vascular bundle differentiating; *Tu* tuber; *X* xylem.

confirmed the observations of Archibald (1967) who wrote "Juvenile plants bear up to four thick *roots** from 2–8 cm long, 2 mm diam, each terminating in a tuber 10–20 mm diam," but our interpretation differs from hers.

We regard the initially elongated, cylindrical organs, their branches, the crown and its branches and the resulting tubers as organs intermediate between a shoot and a root. They not only all originate from the hypocotyl but are also alike in their morphology. A shoot-like anatomical feature is the presence of closed, collateral vascular bundles (Fig. 5). Similar vascular bundles occur in the rhizome of *Rajania cordata* and *Dioscorea caucasica* (Ayensu, 1972) as well as in the seedling stem of *D. cotinifolia* (Fig. 5). The tubers are also similar to rhizomes in that they are perennial storage organs with adventitious roots. The presence of a periderm is a feature found in other monocotyledonous rhizomes, stems and roots (Tomlinson, 1969) and in *D. cotinifolia* a periderm is found in the intermediary organs as well as in the subterranean part of an adventitious stem (Fig. 6B and C). The apices of young, cylindrical intermediary organs have no root-caps, while older tips are covered by a periderm. The tuber tips of other *Dioscorea* species shows this too (Koch and Bruhn, 1962; Martin and Ortiz, 1963). The root-like anatomical features include the absence of a cuticle and stomata. Like roots, the very young intermediary organs have unicellular structures resembling root hairs which probably play a role in the uptake of water and nutrients. The cylindrical intermediary organs are organographically so similar to roots that they have been mistaken for roots (Codd, 1960; Archibald, 1967). As in roots the intermediary organs of *D. cotinifolia* never possess nodes, internodes or any signs of leaves. Von Guttenberg (1968) stated that, with a few exceptions, all monocotyledonous roots have an exodermis and endodermis, neither of which is present in *D. cotinifolia*'s intermediary organs. Unlike the tubers of *D. discolor* (Lindinger, 1907) and *D. batatas* var. *illustrata* (Von Guttenberg, 1968) the tubers of *D. cotinifolia* do not arise from roots.

The presence of a deep-seated lateral meristem, called a growth zone or cambium by other workers, is not too surprising in *Dioscorea* as it occurs in other monocotyledonous organs. Example: the stems of *Cordyline*, *Dracaena* and *Yucca*, where it forms secondary vascular bundles within a secondary ground tissue (Zimmermann and Tomlinson, 1972). This meristem is an outstanding characteristic of many Dioscoreaceae tubers but has never been found in their shoots or roots. In *D. cotinifolia* this meristem is found in the intermediary organs (Fig. 5) and gives rise to secondary vascular bundles, secondary ground tissue as well as lateral branches.

In a cultured seedling in its second growing season, young stems developed adventitiously from the original tuber as well as from a tuberised lateral branch of the crown (Fig. 3I). At the base of each young stem, adventitious roots as well as

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**roots* underlined by authors.

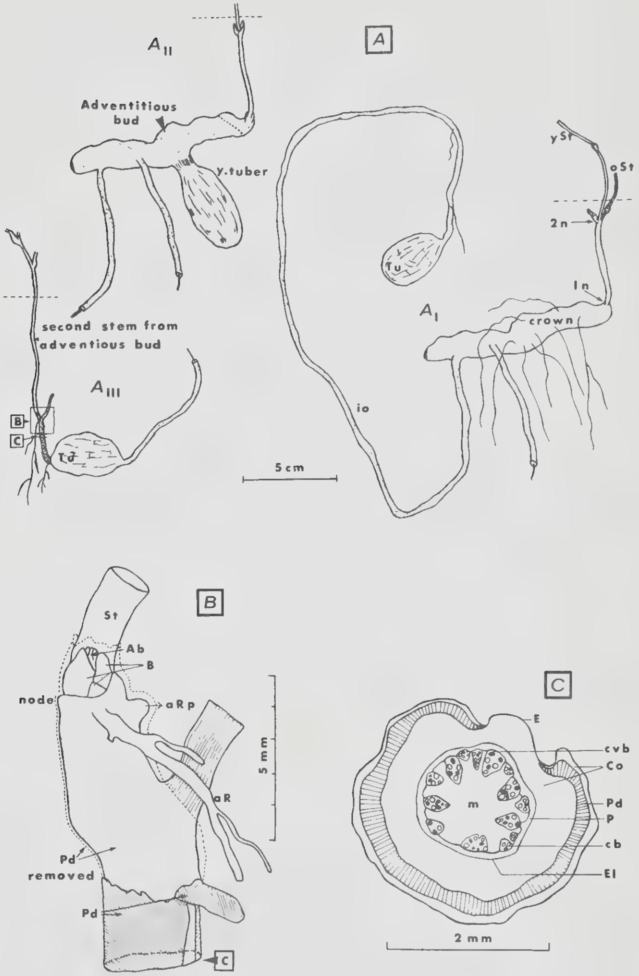

FIG. 6.

An adult plant of *D. cotinifolia* illustrating vegetative reproduction. A_I: tuber system as collected in the field; A_{II}: a part of A_I four months later; A_{III}: a part of A_I 12 months later; B: a part of the adventitious stem in A_{III}; C: Diagrammatic representation of the t.s. of the stem in B. *Ab* axillary bud; *aR* adventitious root; *aRp* adventitious root primordium; *B* bract; *cb* common vascular bundle; *Co* cortex; *cvb* cauline vascular bundle; *E* epidermis; *El* endodermoid layer; *io* intermediary organ; *m* pith; *1n* & *2n* first and second node; *oSt* old stem; *p* pericycle; *pd* periderm; *St* stem; *Tu* old tuber; *ySt* young stem; *y-tuber* young tuber.

two cylindrical intermediary organs developed. The latter became 18 and 25 cm long respectively and tuberised during that season. In other cultured seedling as well as one adult plant collected in the field two similar young adventitious stems developed from each plant. At the base of each young stem a new actively growing crown formed. The two new crowns in each plant remained active for two to four seasons. Generally the tubers of *D. cotinifolia* persisted for about three or four seasons as was also observed by Archibald (1967).

In the beginning of the growing season while the shoot developed, a number of adventitious roots up to 60 cm in length developed from the base of the new shoot. Some of the food reserves of the older tubers probably were utilised in this initial spurt of growth of the shoot. Later in the season existing younger tubers enlarged and tubers formed from newly formed cylindrical intermediary organs or from a thrust of growth from the crown (Fig. 6AI and AII) or from older cylindrical intermediary organs.

4 VEGETATIVE REPRODUCTION

Cylindrical intermediary organs of plants collected in the field were up to 3,3 m in length. Over a period of four seasons, some of these intermediary organs decayed or were broken accidentally during examination. The tubers which were separated from the original plant (e.g. Fig. 6AI) then formed adventitious shoots and developed into new plants. In the example illustrated in Fig. 6AIII, a periderm developed in the cortex of the subterranean part of the adventitious shoot (Fig. 6B and C). This is the first report of a periderm in the shoot of *D. cotinifolia.*

It seems very likely that tubers or intermediary organs can break off from the original plant in its natural habitat. Since all intermediary organs possess a deep-seated lateral meristem (Fig. 5) from which adventitious buds, roots or further intermediary organs can arise, any part of an intermediary organ which breaks off would be likely to form a new plant. This means of vegetative reproduction has been observed in the field by Miège (1950). He described how underground horizontal branches of *D. minutiflora* produced "callosities" and later separate plants at the nodes. In *D. minutiflora* even branches of the aerial shoot behave similarly when they fall to the ground accidentally. Martin and Ortiz (1963) reported the development of separate plants from partially buried stems, stem cuttings and tuber pieces in *D. spiculiflora* and *D. floribunda.*

5 CONCLUSIONS

Germination studies on *D. cotinifolia* indicate that the embryo has only one cotyledon and that: (1) two vascular traces enter the cotyledonary petiole while three enter the first vegetative leaf; (2) the venation of the lamina of these two leaves differs; and (3) the embryo has a minute first vegetative leaf.

It is, therefore, not always possible to classify organs as shoots or roots, and provision should be made, as was stated by Sattler (1974), for a category of organs which are intermediate between the two.

Dioscorea cotinifolia has a specialised tuber system. Our reasons for regarding the initially elongated, cylindrical organs, their branches, the crown and its branches and the resulting tubers as organs intermediate between a shoot and a root are the following: (1) they originate directly or indirectly by branching and tuberisation from the hypocotyl which, in the adult plant, represents the transition region which has "features that are intermediate or transitional between those of a shoot and the root" (Esau, 1967); (2) the growth of the intermediary organs results from the activity of a deep-seated lateral meristem which is neither found in shoots nor in roots of *Dioscorea*; and (3) these organs have characteristics typical of both the shoot and the root.

Besides functioning initially as absorptive organs, the intermediary organs bear adventitious roots which anchor the plant. The tubers serve mainly as storage organs while the cylindrical intermediary organs serve as organs of transport. Any of the intermediary organs may act as vegetative reproductive organs.

It would be interesting to study *D. arcuatinervis, D. mamillata* and *D. proteiformis* from the Malagasy Republic since their tubers are also borne at the end of long cylindrical organs (Burkill, 1950). These tubers might represent highly specialised structures just like those of *D. cotinifolia* and of *D. glabra* which are borne on a sympodial rootstock (Sharma, 1974).

ACKNOWLEDGEMENTS

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APPENDIX Nutrient solution used for seedlings:

Macroelements (gl^{-1})	
$MgSO_4 . 7H_2O$	0,266
KC1	0,302
KH_2PO_4	0,066
$CaH_4(PO_4)_2 . H_2O$	0,072
$CaSO_4 . 2H_2O$	0,249
NH_4NO_3	0,880
$Ca(NO_3)_2 . 4H_2O$	0,354

Microelements according to Hewitt (1952) p. 109: A–Z supplements as under A. MoO_2 $-0,024$ mgl^{-1} and Fe-2 mgl^{-1} using Na Fe. EDTA were also added.

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A PROVISIONAL CHECK LIST OF FLOWERING PLANTS AND FERNS IN THE CAPE HANGKLIP AREA

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(Botanical Research Unit, Stellenbosch)

Abstract

A preliminary list of flowering plants and ferns for the Cape Hangklip area is given. This list is analyzed numerically. A brief comparison is made with the total number of families, genera and species recorded by Adamson and Salter (1950) in their *Flora of the Cape Peninsula* and by Ross (1973) in his *Flora of Natal*. Those families contributing more than 1% towards the total number of species in the area, and those genera containing 15 or more species, are tabulated.

Uittreksel

'N VOORLOPIGE LYS VAN BLOMPLANTE EN VARINGS IN DIE KAAP-HANGKLIP-GEBIED

'n Voorlopige lys van blomplante en varings in die Kaaphangklip-gebied word gegee. Die lys word numeries geanaliseer. 'n Vergelyking word onder andere getrek met die totale aantal families, genera en species genoem deur Adamson en Salter (1950) in hul *Flora van die Kaapse Skiereiland* en deur Ross (1973) in sy *Flora van Natal*. Families wat meer as 1% bydra tot die totale aantal species in die gebied en die genera wat 15 of meer species bevat, word getabuleer.

This list of flowering plants and ferns has been compiled for the area included within the 1 : 50 000 topographic map 3418 BD Hangklip, and includes those portions of the Kogelberg State Forest which occur outside of this map. The area is indicated in Fig. 1.

The list has been compiled from the author's collections in the area between 1968 and 1974. Most of the recent published revisions have been studied for species occurring in the area which had not been collected by the author. Some local botanists who have collected specimens in the area have also been consulted. In this respect grateful thanks are extended to Prof. M. P. de Vos, Miss Elsie Esterhuysen, Mr. E. G. H. Oliver, Mrs. Ez. Powrie, Dr. J. P. Rourke, Prof. E. A. C. L. E. Schelpe, Dr. M. M. Vogts and Dr. I. J. M. Williams. The author's original specimens and collectors' registers are housed in the Botanical Research Unit, Stellenbosch and duplicates have been housed at the Wicht Herbarium, Jonkershoek; the Compton Herbarium, Kirstenbosch; and the Botanical Research Institute, Pretoria. Specimen collection numbers are listed in brackets after each taxon in the check list. Where the taxon has not been collected by the author, another collection from the area is quoted. Identifications have been made by the

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staff of the Botanical Research Institute, both at Stellenbosch and at Pretoria. Certain specialist groups were identified at the Bolus and Compton Herbaria and by private individuals. This check list of 1407 species is by no means complete because of the relatively short period during which specimens were collected and because of the relatively large area (almost 240 sq. km) of difficult and very diverse terrain which added to the difficulties of attempting to visit each habitat regularly throughout the year.

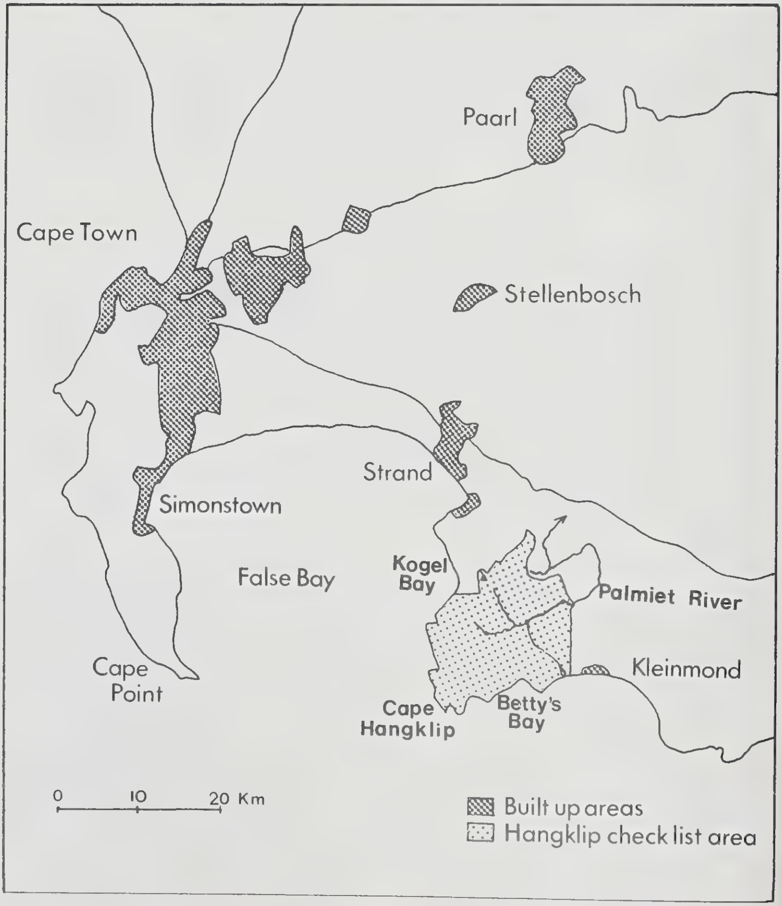


Fig. 1
Geographical location of Cape Hangklip check list area.

The taxa have been arranged as follows: Pteridophyta (nomenclature following Schelpe (1969)), Gymnospermae and Angiospermae (Monocotyledoneae and Dicotyledoneae (nomenclature following Phillips (1951)). The families, genera and species have been arranged alphabetically within each successive group. The most recent revisions have been followed, in most instances, for plant names.

The Cape Hangklip area is relatively small yet the flora is comparatively rich as is indicated in Table 1. Details for the Cape Peninsula have been obtained from Adamson and Salter (1950) and for Natal from Ross (1973).

TABLE 1

Comparison between the numbers of families, genera and species in the Cape Hangklip area, in the Cape Peninsula and in Natal.

	Area in sq. km's	No. of families	No. of genera	No. of species	No. of spp. per sq. km
Cape Hangklip	240	110	430	1 407	5,9
Cape Peninsula	471	129	702	2 622	5,6
Natal	91 385	179	1 238	4 826	0,1

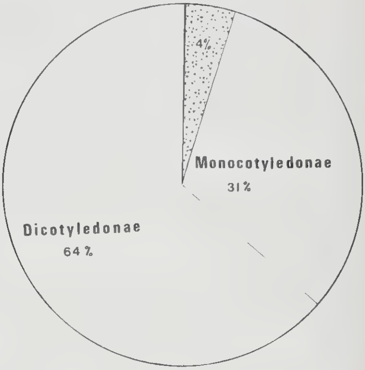
Of the 110 families represented 14 are pteridophytes, three are gymnosperms and 93 are angiosperms. Of these angiosperm families, 16 are monocotyledons and 77 are dicotyledons. Their proportional representation is indicated in Fig. 2.

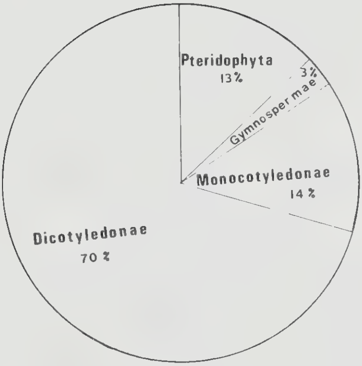
The 435 genera comprise 16 pteridophytes, three gymnosperms and 416 angiosperms. The angiosperms are represented by 136 monocotyledons and 280 dicotyledons. Their proportional representation is indicated in Fig. 3.

There are 1 407 species of which the pteridophytes contribute 24, the gymnosperms five, the monocotyledons 460 and the dicotyledons 918. This relationship is indicated in Fig. 4.

The families whose species contribute more than 1,0% towards the total number of species are listed in order of numerical importance in Table 2. The number of genera present in these families is also reflected in Table 1 but as family position is determined by the total number of species, the arrangement of genera follows no strict sequence. The largest family is Compositae with 51 genera and 152 species followed by Ericaceae with 10 genera and 119 species, and Leguminosae with 22 genera and 103 species. Other families with larger generic complements are Iridaceae (28 genera) and Gramineae (29 genera). In the Cape Peninsula the Compositae consist of 85 genera and 291 species in comparison to the 112 genera and 549 species in Natal, and the approximately 900 genera and over 17 000 species in the world (Dyer, 1976).

Of the 110 families, 38 are represented by a single species, 15 families by two species, 11 families by three species and 8 families by four species. The remaining 34,5% of the families are represented by more than four species. Similarly 58 families are represented by a single genus, 16 families by two genera, 13 families





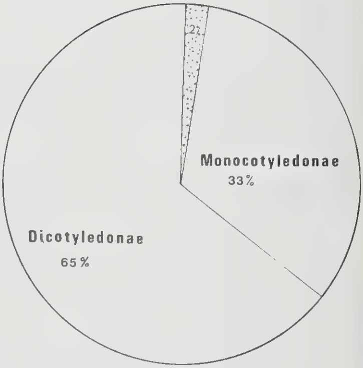


FIG. 2

Diagrammatic representation of the relationship between the numbers of families of the pteridophytes, gymnosperms, monocotyledons and dicotylendons.

FIG. 3

Diagrammatic representation of the relationship between the numbers of genera of the pteridophytes and gymnosperms (shaded) and the monocotyledons and dicotyledons.

FIG. 4

Diagrammatic representation of the relationship between the numbers of species of the pteridophytes and gymnosperms (shaded) and the monocotyledons and dicotyledons.

TABLE 2

Synopsis of families whose species contribute more than 1% towards the total number of species, together with the number of genera in each family.

Family	No. of species	No. of species expresses as a % of the total	No. of genera	No. of genera expressed as a % of the total
Compositae	152	10,8	51	11,6
Ericaceae	119	8,5	10	2,3
Leguminosae	103	7,3	22	5,1
Restionaceae	100	7,1	10	2,3
Iridaceae	98	7,0	28	6,5
Cyperaceae	71	5,0	15	3,5
Gramineae	64	4,5	29	6,7
Proteaceae	62	4,4	13	3,0
Orchidaceae	55	3,9	18	4,2
Campanulaceae ..	44	3,1	12	2,8
Liliaceae	44	3,1	18	4,2
Scrophulariaceae .	26	1,8	14	3,2
Umbelliferae	26	1,8	11	2,6
Thymelaeaceae ..	26	1,8	5	1,2
Rutaceae	23	1,6	7	1,6
Bruniaceae	22	1,6	7	1,6
Geraniaceae	22	1,6	3	0,7
Polygalaceae	22	1,6	3	0,7
Rosaceae	20	1,4	2	0,5
Aizoaceae	17	1,2	10	2,3
Santalaceae	15	1,1	3	0,7

by three genera and 2 families by four genera, leaving a remainder of 21,8% of the families represented by more than four genera. The ratio of genera to species is 1 : 3,24 in contrast to 1 : 3,73 on the Cape Peninsula, 1 : 3,89 for Natal, 1 : 3,52 for South West Africa and 1 : 4,21 for West Tropical Africa (Ross, 1973). The figure for the Cape Hangklip area is lower than any of the other figures implying a larger proportion of genera with fewer species. There are 230 genera represented by a single species, 67 genera by two species, 51 genera by three species and 19 genera by four species. The genera with the largest number of species in the Cape Hangklip area are listed in Table 3. The largest genus, by far, is *Erica* with 98 species followed by *Aspalathus* with 35 species.

Restio having 36 species, is the largest monocotyledonous genus. This latter proportion of species corresponds with the generally ericoid and restioid nature of the vegetation.

Introduced but naturalized species mainly originating from Australia are: *Hakea sericea, Leptospermum laevigatum, Eucalyptus ficifolia, E. lehmannii, Acacia cyclops, A. longifolia, A. mearnsii, A. saligna* and *Albizia lophantha. Ammophila arenaria, Briza maxima, Erigeron canadense, Lagurus ovatus, Populus canescens, Pinus pinaster* and *P. radiata* originate in the northern

TABLE 3

Synopsis of the genera with 15 or more species, listed in order of numerical importance.

Genus	No. of species
Erica	98
Restio	36
Aspalathus	35
Ficinia	27
Senecio	22
Cliffortia	19
Elegia	18
Pelargonium	17
Lobelia, Helichrysum, Pentaschistis	16
Tetraria, Protea, Disa	15

hemisphere. *Lantana camara*, a tropical American shrub, has been recorded from roadsides. Most garden weeds and introduced exotic annuals have been excluded. *Virgilia oroboides* is a doubtful inclusion being found in and around the Harold Porter Botanic Garden and around the Oudebos farm. This species is now regenerating naturally after fire at these localities. Certain other indigenous species not occurring naturally in the Cape Hangklip area have also been introduced into private properties. These have mostly been excluded.

The area is relatively poorly collected botanically and many new records will undoubtedly still be found. The author, during the period 1968 to 1974, collected 23 taxa which did not conform to any descriptions available. Of these five were Ericaceae, four were Rutaceae and three were Restionaceae. Access routes in the area have been considerably improved recently and many areas have recently been burnt after long periods of protection. Many additions to this check list can therefore be expected.

The advent of large scale township development along the coast and the construction of large dams in the area will obviously have an adverse effect on both individual species and on the communities as a whole.

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PTERIDOPHYTA

ADIANTACEAE

Adiantum aethiopicum L. (2182)
A. capillus-veneris L. (1929)
Pellaea pteroides (L.) Prantl (1114)

ASPIDIACEAE

Rumohra adiantiformis (Forst.) Ching (313)

ASPLENIACEAE

Asplenium adiantum-nigrum L. (1847)

BLECHNACEAE

Blechnum attenuatum (Swartz) Mett. var. *giganteum* Schlechtd. (1621)
B. capense (L.) Schlechtd. (220/5, 314)
B. punctulatum Swartz (2188)
B. tabulare (Thunb.) Kuhn (46)

CYATHEACEAE

Alsophila capensis (L.f.) J.E.Sm. (1620)

DENNSTAEDTIACEAE

Histiopteris incisa (Thunb.) J.E.Sm. (220/4)
Pteridium aquilinum (L.) Kuhn (1311)

GLEICHENIACEAE

Gleichenia polypodioides (L.) J.E.Sm. (43)

HYMENOPHYLLACEAE

Hymenophyllum capense Schrad. (339)
H. tunbridgense (L.) J.E.Sm. (312)

LOMARIOPSIDACEAE

Elaphoglossum acrostichoides (Hook.) Schelpe (315)
E. conforme (Swartz) J.E.Sm. (2043)

LYCOPODIACEAE

Lycopodium carolinianum L. (414, 1168)
L. clavatum L. (1501)
L. gnidioides L.f. (Haynes 335)

OSMUNDACEAE

Todea barbara (L.) Moore (1300)

POLYPODIACEAE

Pleopeltis macrocarpa (Willd.) Kaulf. (1653)

SCHIZAEACEAE

Schizaea pectinata (L.) Swartz (174)

THELYPTERIDACEAE

Thelypteris confluens (Thunb.) Morton (1113)

GYMNOSPERMAE

CUPRESSACEAE

Widdringtonia nodiflora (L.) Powrie (298)

PINACEAE

Pinus pinaster Ait. (1322)
P. radiata D.Don (Field observation)

PODOCARPACEAE

Podocarpus elongatus (Ait.) L'Hérit. ex Pers. (1485)
P. latifolius (Thunb.) R.Br. (317, 885, 2077)

ANGIOSPERMAE: MONOCOTYLEDONEAE

AMARYLLIDACEAE

Brunsvigia orientalis (L.) Ait. ex Eckl. (1444)
Cyrtanthus angustifolius (L.f.) Ait. (1172, 1786)
C. leucanthus Schltr. (1157, 1275, 1825)
C. ventricosus Willd. (1454)
Haemanthus canaliculatus Levyns (1171—sheets 1 & 2).
H. coccineus L. (1188, 1471)
H. rotundifolius Ker-Gawl. (1130)
Nerine sarniensis Herb. (2151)

APONOGETONACEAE

Aponogeton distachyos L.f. (1227)

ARACEAE

Zantedeschia aethiopica (L.) Spreng. (457)

COMMELINACEAE

Commelina africana L. (1395)

CYPERACEAE

Carex clavata Thunb. (680)
Carpha glomerata Nees (911, 1054)
Chrysithrix capensis L. (1115, 2038, 2057)
C. junciformis Nees (Stehle 247)
Cyperus denudatus L.f. (1733)
C. sphaerospermus Schrad. (1226)
C. thunbergii Vahl (681)
Epischoenus complanatus Levyns (1246)
E. gracilis Levyns (1059)
E. quadrangularis C.B.Cl. (49, 1212)

Epischoenus villosus Levyns (1218)
Ficinia acuminata (Steud.) Nees (1848)
F. albicans Nees (834)
F. anceps Nees (B111, 1296)
F. bulbosa (L.) Nees (451, 1361)
F. capitella (Thunb.) Nees (1871)
F. capillifolia (Schrad.) C.B.Cl. (40)
F. composita (Nees) Nees (1702)
F. deusta (Berg.) Levyns (B75, 698)
F. dunensis Levyns (1356)
F. elatior Levyns (1068)
F. filiformis (Lam.) Schrad. (439, 950)
F. indica (Lam.) Pfeiffer (707)
F. ixioides Nees (1939, 1940)
F. lateralis (Vahl.) Kunth (942, 1492)
F. levynsae Arnold (B61)
F. longifolia C.B.Cl. (1202)
F. minutiflora C.B.Cl. (1811)
F. monticola Kunth (370)
F. nigrescens (Schrad.) Raynal (979, 635, 1293, 1346, 1550, 1505)
F. pallens (Schrad.) Nees var. *lithosperma* (Boeck.) Arnold (704)
F. pinguior C.B.Cl. (1475, 1918)
F. pusilla C.B.Cl. (1625)
F. ramosissima Kunth (347, B43)
F. tribracteata Boeck. (B114(a))
F. trichodes (Schrad.) Benth. & Hook. (1506)
F. tristachya Nees (764)
F. zeyheri Boeck. (1164)
Fuirena hirsuta (Berg.) Forbes (668)
Kobresia lancea (Thunb.) Koyama (1622)
Macrochaetium hexandrum (Lam.) Pfeiffer (650, 1272)
Mariscus congestus C.B.Cl. (1040)
Neesenbeckia punctoria (Vahl) Levyns (1209, 1321, 1480)
Schoenus nigricans L. (655, 1090, 1715)
Scirpus cartilagineus (R.Br.) Poir. (727)
S. digitatus (Schrad.) Boeck. (709, 873)
S. ecklonii Steud. (767)
S. fluitans L. (691)
S. incomptulus (Nees) Boeck. (487)
S. littoralis Schrad. (1519)
S. membranaceus Thunb. (669, 1540)
S. nodosus Rottb. (653, 1091)
S. prolifer Rottb. (1734, 1943)
S. tenuissimus Boeck. (2659)
S. venustulus (Kunth) Boeck. (1596)
Sickmannia radiata (L.f.) Nees (632)
Tetraria brachyphylla Levyns (1936)
T. brevicaulis C.B.Cl. (B39)
T. bromoides (Lam.) Pfeiffer (279, 1728)
T. capillacea (Thunb.) C.B.Cl. (332, 416, 1210)
Tetraria compar (L.) Lestib. (378, 1011, 1743, B38)
T. crinifolia C.B.Cl. (1713)
T. cuspidata (Rottb.) C.B.Cl. (33, 304, 1062, 1155, 1178, B37)
T. exilis Levyns (1252)
T. eximia C.B.Cl. (1365)
T. fasciata (Rottb.) C.B.Cl. (306)
T. fimbriolata C.B.Cl. (1015)
T. flexuosa (Thunb.) C.B.Cl. (2107)
T. lucida C.B.Cl. (49)
T. microstachys (Vahl) Pfeiffer (1289)
T. thermalis C.B.Cl. (327)

GRAMINEAE

Agropyron distichum (Thunb.) Beauv. (1688)
Aira cupaniana Guss. (1668)
Ammophila arenaria (L.) Link. (2660)
Aristida junciformis Trin. & Rupr. subsp. *junciformis* (1343, 2458)
Briza maxima L. (1730)
Cymbopogon marginatus (Steud.) Stapf (552, 1826)
Cynodon dactylon (L.) Pers. (Field observation)
Ehrharta bulbosa Sm. (1716)
E. calycina J.E.Sm. (1742)
E. dodii Stapf (2039)
E. dura Nees ex Trin. (2028)
E. erecta Lam. (1774)
E. microlaena Nees ex Trin. (173)
E. ottonis Kunth (172, 493, 798)
E. ramosa Thunb. (1661, 1724)
E. rehmannii Stapf (1456)
E. tricostata Stapf (2069)
E. uniflora Burch. (Esterhuysen 33056)
E. villosa Schult.f. (1689)
Eragrostis curvula (Schrad.) Nees (2457)
E. elatior Stapf (1014)
E. sabulosa (Steud.) Schweick. (661)
Festuca scabra Vahl (705, 1405, 1641)
Helictotrichon hirtulum (Steud.) Schweick. (494)
Hyparrhenia filipendula (Hochst.) Stapf var. *pilosa* (Hochst.) Stapf (495)
Imperata cylindrica (L.) Beauv. (2001)
Lagurus ovatus L. (654)
Lasiochloa longifolia (Schrad.) Kunth (755)
Merxmuelera cincta (Nees) Conert (948)
M. lupulina (Thunb.) Conert (Taylor 3214)
M. rufa (Nees) Conert (178, 1723)
Pennisetum macrourum Trin. (1313)

Pentameris macrocalycina (Steud.) Schweick. (1649)
P. thuarii Beauv. (Taylor 7231)
P. sp. (2095)
Pentaschistis acinosa Stapf (2033, 2656)
P. ampla (Nees) McClean (1056)
P. aristidoides (Thunb.) Stapf (1649)
P. angustifolia (Nees) Stapf var. *albescens* Stapf (943)
P. aspera (Thunb.) Stapf (1404, 1656)
P. capensis (Nees) Stapf (2075)
P. colorata (Steud.) Stapf (990, 1672, 1700)
P. curvifolia (Schrad.) Stapf (935, 1673)
P. eriostoma (Nees) Stapf (1722)
P. involuta (Steud.) Adamson (1194)
P. juncifolia Stapf (179)
P. patula (Nees) Stapf (1731)
P. steudelii (Nees) McClean (937, 1191, 1729)
P. thunbergii (Kunth) Stapf (2663)
P. tysonii Stapf (353)
P. viscidula (Nees) Stapf (380)
Phragmites australis (Cav.) Trin. ex Steud. (1496)
Plagiochloa uniolae (L.f.) Adamson & Sprague var. *uniolae* (1657, 1944)
P. uniolae (L.f.) Adamson & Sprague var. *villosa* (Stapf) Adamson (773)
Poagrostis pusilla (Nees) Stapf (1784)
Polypogon strictus Nees (658)
Pseudopentameris brachyphylla (Stapf) Conert (357a, 1938)
P. macrantha (Schrad.) Conert (2661)
Sporobolus africanus (Poir.) Robyns & Tournay (450)
S. virginicus (L.) Kunth (1521, 1829)
Stenotaphrum secundatum (Walt.) Kuntze (1830)
Stipa dregeana Steud. (2662)
Stipagrostis zeyheri (Nees) de Wint. subsp. *zeyheri* (1107)
Themeda triandra Forsk. (591)

HAEMODORACEAE

Cyanella hyacinthoides L. (909)
Dilatris pillansii W.F. Barker (839)
D. viscosa L.f. (1996)
Lanaria lanata (L.) Dur. & Schinz. (176)
Wachendorfia paniculata Burm. (1905, 2423)
W. thyrsiflora L. (820)
W. sp. (828)

HYPOXIDACEAE

Empodium plicatum (Thunb.) Garside (1274)
Spiloxene capensis (L.) Garside (394, 476, 686, 1298)
S. curculigoides (H.Bol.) Garside (de Vos 1005)
S. flaccida (Nel) Garside (477)
S. monophylla (Schltr.) Garside (44, 926, 1131)

IRIDACEAE

Anapalina caffra (Bak.) Lewis (2068)
A. nervosa (Thunb.) Lewis (959, 960)
A. pulchra (Bak.) N.E.Br. (22, 374)
A. triticea (Burm.) N.E.Br. (1117)
Anomalesia cunonia (L.) N.E.Br. (664)
Aristea africana (L.) Hoffmg. (576)
A. bakeri Klatt (818, 1913)
A. cuspidata Schinz (396)
A. juncifolia Bak. (25, 165, 191)
A. major Andr. (Grobler 29 282)
A. oligocephala Bak. (999, 1111)
A. racemosa Bak. (1915)
A. spiralis (L.f.) Ker-Gawl. (808, 883)
Babiana nana (Andr.) Spreng. var. *angustifolia* (Eckl.) Lewis (de Vos 608)
B. stricta (Ait.) Ker-Gawl. (Harold Porter Botanic Garden No.65)
Bobartia aphylla Ker-Gawl. (de Vos 205)
B. gladiata Ker-Gawl. (6, 375)
B. indica L. (807, 1482)
Chasmanthe aethiopica (L.) N.E.Br. (1538)
C. floribunda (Salisb.) N.E.Br. (1352)
Engysiphon sp. (2426)
Ferraria undulata L. (738)
Geissorhiza aspera Goldblatt (674, 1704)
G. bolusii Bak. (1942)
G. graminifolia Bak. (de Vos 671)
G. hesperanthoides Schltr. (2053)
G. imbricata (de la Roche) Ker-Gawl. (430)
G. inflexa (de la Roche) Ker-Gawl (1894)
G. juncea (Link.) A. Dietr. (1659)
G. ornithogaloides Klatt (189)
G. ovata (Burm. f.) Aschers & Graeb. (585, 1409)
G. wrightii Bak. (1407)
G. sp. (189)
Gladiolus brevitubus Lewis (188)
G. brevifolius Jacq. (1175)
G. bullatus Thunb. ex Lewis (644, 1908)
G. carinatus Ait. (676)
G. carmineus C.H.Wr. (Compton 22 720)

Gladiolus carneus de la Roche (1406)
G. debilis Ker-Gawl. var. *debilis* (584)
G. debilis Ker-Gawl. var. *cochleatus* (Sw.) Lewis (Esterhuysen 31416)
G. gracilis Ker-Gawl. (1372)
G. hyalinus Jacq. (1647)
G. maculatus Sw. (1323)
G. pillansii Lewis var. *roseus* Lewis (1217)
G. punctulatus Schrank. var. *punctulatus* (719, 2180)
G. subcaeruleus Lewis (1478)
G. undulatus L. (2021)
Hesperantha falcata Ker-Gawl. (675)
Homeria collina (Thunb.) Vent. (694, 1396)
H. galpinii L.Bol. (Rycroft 2266)
Homoglossum priori N.E.Br. (1292)
Ixia dubia Vent. (1410)
I. flexuosa L. (672)
I. micrandra Bak. (1640)
I. odorata Ker-Gawl. (583)
I. paniculata de la Roche (Porter s.n. BOL 26897)
I. polystachya L. var. *lutea* (Ker-Gawl.) Lewis (700)
Klattia stokoei L.Guth. (Taylor 7235)
Lapeirousia corymbosa Ker-Gawl. (1697)
L. micrantha (E.Mey. ex Klatt) Bak. (Dr. P. Goldblatt pers. comm.)
Melasphaerula ramosa (L.) N.E.Br. (489)
Micranthus alopecuroides (L.) Rothm. (1008)
M. junceus (Bak.) N.E.Br. (1822)
Moraea angusta (Thunb.) Ker-Gawl. (695)
M. bellendenii N.E.Br. (Werdermann & Oberdieck 287)
M. gawleri Spreng. (Dr. P. Goldblatt pers. comm.)
M. lurida Ker-Gawl. (925)
M. neglecta Lewis (788)
M. odorata Lewis (Dr. P. Goldblatt pers. comm.)
M. ramosissima (L.f.) Druce (214, 1401)
M. tenuis Ker-Gawl. (809, 1902)
M. tricuspidata (L.f.) Lewis (1903)
M. tripetala Ker-Gawl. (624, 1949)
Nivenia levynsiae Weim. (1032, 1152)
N. stokoei (L.Guth.) N.E.Br. (1109, 1154)
Pillansia templemannii (Bak.) L.Bol. (168)
Romulea flava (Lam.) de Vos var. *flava* (de Vos 2008)
R. rosea Eckl. var. *reflexa* Beg. (1594)
R. rosea Eckl. var. *rosea* (de Vos 2248)
R. triflora (Burm.f.) N.E.Br. (1593)
Sparaxis grandiflora (de la Roche) Ker-Gawl. subsp. *violacea* (Eckl.) Goldbl. (1397)
Thereianthus bracteolatus (Lam.) Lewis (870)
T. juncifolius (Bak.) Lewis (1788)
T. lapeyrousioides (Bak.) Lewis (Rycroft 1354)
T. spicatulus (L.) Lewis var. *linearifolius* Lewis (377, 957, 972)
Tritonia lacerata (Burm.f.) Klatt (908)
Tritoniopsis caledonensis (Foster) Lewis (1725)
T. lata (L.Bol.) Lewis (354)
T. unguicularis (Lam.) Lewis (170)
T. parviflora (Jacq.) Lewis (166)
T. pulchella Lewis (1190, 2066)
T. ramosa (Eckl. ex Klatt) Lewis var. *ramosa* (8, 393)
Watsonia angusta Ker-Gawl. (355, 2042)
W. comptonii L.Bol. (402)
W. humilis Rill. (1708)
W. meriana Mill. (356)
W. pyramidata (Andr.) Stapf (373, 850)
W. zeyheri L.Bol. (2022)
Witsenia maura (L.) Thunb. (918)

JUNCACEAE

Juncus dregeanus Kunth (1455)
J. kraussii Hochst. (653(a))
J. lomatophyllus Spreng. (2455)
Prionium serratum (L.f.) Drege (1754)

JUNCAGINACEAE

Triglochin bulbosa L. (2657)

LILIACEAE

Agapanthus africanus (L.) Hoffmg. (211, 1817)
A. walshii L.Bol. (1805, 2067)
Albuca canadensis (L.) Leighton (1664, 2027)
A. cooperi Bak. (760)
Aloe succotrina Lam. (582)
Androcymbium eucomoides (Jacq.) Willd. (460)
Asparagus aethiopicus L. (1503, 1695)
A. asparagoides (L.) Wight (444)
A. capensis L. (848)
A. compactus Salter (1344)

Asparagus crispus Lam. (1360)
A. scandens Thunb. (311, 1687)
A. stipulaceus Lam. (1534, 1824)
A. thunbergianus Schult. (1173)
Baeometra uniflora (Jacq.) Lewis (1897)
Bulbine favosa (Thunb.) Roem. & Schult. (1185)
B. filifolia Burch. (1893)
B. tuberosa (Mill.) Oberm. (1224)
Bulbinella triquetra Kunth (1204)
Caesia contorta (L.f.) Dur. and Schinz (953)
Dipidax punctata (L.) Hutch. (1898)
Eriospermum cernuum Bak. (2062)
E. pumilum Salter (2460)
E. sp. cf. *E. schlechteri* Bak. (2752)
Kniphofia tabularis Marl. (2721)
K. uvaria (L.) Hook. (1460)
Lachenalia bulbifera (Cyr.) Hort. (1513)
L. glaucina Jacq. var. *pallida* Lindl. (492, 2428)
L. peersii Marloth ined. (739, 1408)
L. rosea Andr. (1896, 2427)
Ornithogalum graminifolium Thunb. (1108)
Rhadamanthus montanus B.Nord. (1776)
Trachyandra ciliata (L.f.) Kunth (534)
T. divaricata (Jacq.) Munth (659)
T. esterhuysenae Oberm. (988)
T. hirsuta (Thunb.) Kunth (216, 1294)
T. hirsutiflora (Adamson) Oberm. (804)
T. revoluta (L.) Kunth (1821)
T. tabularis (Bak.) Oberm. (777)
Tulbaghia aliacea L.f. (1486)
Urginea dregei Bak. (958, 1020, 1120)
U. exuviata (Jacq.) Steinh. (1718)
U. filifolia (Jacq.) Steinh. (1772)
U. gracilis Duthie (164)
U. salteri (Compton) Adamson (912)

ORCHIDACEAE

Acrolophia capensis (Berg.) Fourcade (1063)
A. micrantha (Lindl.) Schltr. & Bolus (1614)
Bartholina ethelae H.Bol. (E.G.H. Oliver field observation)
Bonatea speciosa (L.f.) Willd. (2421)
Ceratandra atrata (L.) Dur. & Schinz (824)
Corycium carnosum (Lindl.) Rolfe (Oliver 3045)
Disa cornuta (L.) Swartz (1457)
Disa cylindrica (Thunb.) Swartz (811, 825, 1994)
D. ferruginea (Thunb.) Swartz (1844)
D. glandulosa Burch. (Oliver 3040)
D. micropetala Schltr. (Oliver 3037 & 3044)
D. neglecta Sond. (1643)
D. obtusa Lindl. (833)
D. pillansii L.Bol. (2032)
D. racemosa L.f. (1999)
D. tabularis Sond. (812)
D. tenuicornis H.Bol. (830)
D. tripetaloides (L.f.) N.E.Br. (816)
D. uncinata H.Bol. (887)
D. uniflora Berg. (1451)
D. vaginata Harv. (886, 1712)
Disperis capensis (L.f.) Swartz (1369)
D. paludosa Harv. (Oliver 3036)
Evota bicolor (Sond.) Rolfe (Oliver 3042)
E. harveyana (Lindl.) Rolfe (Oliver 3041)
Herschelia graminifolia (Ker-Gawl.) Dur. & Schinz (1116)
H. lacera (Swartz) Lewis (1067)
H. purpurascens (H.Bol.) Kranzl. (778)
Holothrix villosa Lindl. (743)
H. lithophila Schltr. (198)
Liparis capensis Lindl. (1326, 1516)
Monadenia bolusiana Schltr. (1946)
M. ophrydea Lindl. (829)
M. micrantha Lindl. (699, 2422)
M. reticulata Dur. & Schinz. (1642)
Orthopenthea bivalvata (L.f.) Rolfe (2893)
O. fasciata (Lindl.) Rolfe (815)
O. obtusa (Lindl.) Schelpe (1644)
O. sp. (831)
Pachites bodkini H.Bol. (Oliver 3038)
Penthea patens (L.f.) Swartz (1034)
Pterygodium acutifolium Lindl. (1995)
P. catholicum (L.) Swartz (491, 814)
P. rubiginosum Sond. (1711)
Satyrium bicallosum Thunb. (1411)
S. bicorne (L.) Thunb. (1947)
S. bracteatum Thunb. (832)
S. carneum (Dry.) R.Br. (693)
S. coriifolium Swartz (692)
S. emarcidum H.Bol. (744)
S. humile Lindl. (781)
S. lupulinum Lindl. (826)
S. lindleyanum H.Bol. (813)
S. stenopetalum Lindl. var. *brevicalcaratum* H.Bol. (de Vos 704)
Schizodium obliquum Lindl. (429, 1370)

POTAMOGETONACEAE

Ruppia maritima L. (1595)

RESTIONACEAE

Cannomois scirpoides Mast. (1727)
C. virgata Steud. (1257, 1748)
Chondropetalum deustum Rottb. (20, 1450, 1517)
C. ebracteatum Pillans (2087)
C. hookerianum Pillans (56, 305, 1515, 1833)
C. marlothii Pillans (Stokoe s.n. BOL 17662)
C. microcarpum Pillans (2101)
C. mucronatum (Nees) Pillans (van Greuning 40)
C. nitidum Pillans (1308)
C. nudum Rottb. (1435)
C. tectorum Pillans (1376, 1474)
Elegia asperiflora Kunth var. *asperiflora* (718)
E. asperiflora Kunth var. *lacerata* Pillans (1307)
E. capensis (Burm. f.) Schelpe (de Vos 1301)
E. cuspidata Mast. (806, 1163)
E. equisetacea Mast. (390, 1314)
E. fistulosa Thunb. (690)
E. intermedia Pillans (1335)
E. juncea L. (1022)
E. neesii Mast. (412, 2045)
E. parviflora Kunth (712(a), 938, 1105, 1271)
E. persistens Mast. (631, 1166)
E. prominens Pillans (Esterhuysen 30651)
E. racemosa Pers. (36, 1153)
E. spathacea Mast. (295, 1036, 1307)
E. stipularis Mast. (611, 949)
E. thyrsifera Pers. (1442)
E. vaginulata Mast. (1719, 2098)
E. sp. (1303, 1305, 2099, B17)
E. sp. (Stokoe 9522, Esterhuysen 9635)
Hypolaena crinalis Pillans (Field observation)
H. diffusa Mast. (B24)
H. digitata (Thunb.) Pillans (936, 1319, 1354, 1658)
Hypodiscus albo-aristatus Mast. (982, 1304, 1909)
H. aristatus Nees (1231)
H. alternans Pillans (1146, 1213)
H. argenteus Mast. (427, 1005)
H. binatus Mast. (1721)
H. willdenowia Mast. (1539, 1639, 2199, B79)
Leptocarpus asper Pillans (B5)
Leptocarpus distichus (Rottb.) Pillans (712(b), 1714)
L. ejuncidus Pillans (1262)
L. fruticosus Mast. (941, 1076, 1141, 1359, 2102)
L. hyalinus (Mast.) Pillans (1541)
L. membranaceus Pillans (1160, 1276)
L. nudiflorus Pillans (Stehle 244)
L. paniculatus Mast. (2749)
L. stokoei Pillans (Esterhuysen 31379)
L. sp. (1233)
Restio ambiguus Mast. (B115)
R. bifarius Mast. (349)
R. bifidus Thunb. (689, 1253, 1337, B28, B34)
R. bifurcus Nees (1004, 1747)
R. brachiatus Pillans (1312)
R. burchellii Pillans (2088, 2133, 2202)
R. callistachyus Kunth (2436)
R. cascadensis Pillans (916, 1203)
R. compressus Rottb. (2149)
R. confusus Pillans (Stokoe s.n. BOL 17703 ♂)
R. curviramis Kunth (1255, 2195)
R. cuspidatus Thunb. (1507, 1917, 2121)
R. debilis Nees (42, 1232)
R. dispar Mast. (280, 1200, 1336)
R. egregius Hochst. (288, 1006, 2108)
R. eleocharis Nees ex Mast. (665, 940, 1139)
R. festucaeformis Nees ex Mast. (539)
R. filiformis Poir (987, 1933, 1935)
R. fraternus Kunth (1858)
R. fruticosus Thunb. (Esterhuysen 31659)
R. fusiformis Pillans (Stehle 245)
R. laniger Kunth ((?) Mund s.n. ♂ only)
R. multiflorus Spreng. (2437)
R. obtusissimus Steud. (331, 1259, 1547)
R. occultus Pillans (de Vos 1367)
R. pachystachyus Kunth (1709)
R. paludosus Pillans (Esterhuysen 32088)
R. pedicellatus Mast. (1626)
R. purpurascens Nees ex Mast. (330)
R. sarcocladus Mast. (1319(a))
R. sieberi Mast. (14)
R. similis Pillans (B4)
R. stokoei Pillans (291, 348, 1251)
R. subverticillatus Mast. (405)
R. tenuissimus Kunth (1710)
R. triticeus Rottb. (1315)
Staberoha aemula Pillans (van Greuning 16)
S. cernua Dur. & Schinz (299, 706, 1916)
S. sp. (2251)
Thamnochortus dichotomus R.Br. (610)
T. erectus Mast. (682)

Thamnochortus fraternus Pillans (670)
T. fruticosus Berg. (590, 708)
T. gracilis Mast. (431, B9)
T. guthrieae Pillans (1542)
T. insignis Mast. (1084)
T. pellucidus Pillans (697)
T. pulcher Pillans (294, 434, 1093, B8, B21, B31)
Willdenowia argentea Hieron. (392, 1195, 1221)
W. humilis Mast. (324)
W. lucaeana Kunth (1355, 1920, 1937, 2122)
W. teres Thunb. (441, 605)

TYPHACEAE

Typha latifolia L. subsp. *capensis* Rohrb. (1520)

ANGIOSPERMAE: DICOTYLEDONEAE

AIZOACEAE

Aizoon sarmentosum L.f. (910, 1388)
Carpobrotus acinaciformis (L.) L.Bol. (456)
Drosanthemum floribundum (Haw.) Schwant. (479)
Erepsia anceps (Haw.) Schwant. (964, 1849)
E. inclaudens Haw. (570)
Lampranthus aurantiacus (DC.) Schwant. (516, 934)
L. austricolus (L.Bol.) L.Bol. (614, 963, 1085, 1103)
L. erratus (Salm-Dyck) N.E.Br. (1816, 1850)
L. serpens L.Bol. (de Vos 635)
Micropterum herrei Schwant. (1412)
Pharnaceum cordifolium L. (1612)
P. elongatum (DC.) Adamson (726)
Ruschia schollii L.Bol. var. *caledonica* L.Bol. (de Vos 634)
R. sarmentosa (Haw.) Schwant. (B92)
R. sp. (740)
Skiatophytum tripolium (L.) L.Bol. (900)
Tetragonia decumbens Mill. (447, 482, 1495)

ANACARDIACEAE

Heeria argentea (E.Mey.) Kuntze (1183, 2463)
Laurophyllus capensis Thunb. (320, 424, 901, 1467)
Rhus africana Mill. (124, 716, 1196, 1484)
R. crenata Thunb. (1694)
R. cuneifolia Thunb. (1549, 2104)
Rhus laevigata L. (1078, 1140)
R. lucida L. var. *scoparia* Eckl. & Zeyh. (946)
R. rosmarinifolia Vahl (2129)
R. schlechteri Diels (1441)
R. scytophylla Eckl. & Zeyh. (465, 517, 1380)
R. tomentosa L. (537)
R. undulata Jacq. (1301)

AQUIFOLIACEAE

Ilex mitis (L.) Radik. (360, 2073)

ARALIACEAE

Cussonia thyrsiflora Thunb. (423, 526)

ASCLEPIADACEAE

Astephanus neglectus Schltr. (1357)
A. triflorus (L.f.) Schultes (B84)
Asclepias rotundifolia Mill. (547)
Cynanchum africanum R.Br. (776)
C. ellipticum R.A.Dyer (1302)
C. obtusifolium L. (931)
Oncinema lineare (L.f.) Bullock (1211)
Secamone alpinii Schultes (1692)
Stapelia variegata L. (1814)

BALANOPHORACEAE

Mystropetalon thomii Harv. (1180, 1187)

BORAGINACEAE

Lobostemon montanus Bueck. (497)

BRUNIACEAE

Berzelia abrotanoides Brongn. (573, 687)
B. dregeana Colozza (17, 408, 1333)
B. ecklonii Pillans (876)
B. lanuginosa (L.) Brongn. (435, 540, 574)
B. sp. (Mrs. E. Powrie pers. comm.)
Brunia albiflora Phillips (287)
B. alopecuroides Thunb. (Stokoe 2581)
B. laevis Thunb. (Jordaan 821)
B. neglecta Schltr. (641, 1777)
B. nodiflora L. (Grobler 0240)
B. stokoei Phillips (1094, 1813 (a))
Lonchostoma monogynum (Vahl) Pillans (1123)
L. purpureum Pillans (1241, 2205)
Nebelia fragarioides (Willd.) Kuntze (418)
N. paleacea Sweet (26)
Pseudobaeckea africanum Pillans (144)
P. cordata Nieden. (1331)
Raspalia microphylla (Thunb.) Brongn. (24, 2046)

Raspalia variabilis Pillans (Esterhuysen 9969)
R. virgata (Brongn.) Pillans (915, 2206)
Staavia brownii Duemmer (Stokoe s.n. BOL)
S. radiata (L.) Dahl (523)

CAMPANULACEAE

Cyphia bulbosa (L.) Berg. (478)
C. digitata (Thunb.) Willd. (2183)
C. volubilis (Burm.f.) Willd. (640)
Laurentia arabidea (Presl) A.DC. (de Vos 786)
L. pygmaea (Thunb.) Sond. var. *obtusiloba* Sond. (336)
L. secunda (L.f.) Kuntze (1801)
Lightfootia axillaris Sond. (213, 2456)
L. oppositifolia A.DC. (Esterhuysen 12566)
L. parvifolia (Berg.) Adamson (1125, 1228)
L. subulata L'Hérit. (1121)
L. tenella (L.) A.DC. (1074)
Lobelia anceps L.f. (947, 1058, 1489)
L. capillifolia (Presl) A.DC. (965, 1845)
L. capillifolia (Presl) A.DC. forma *pinnatifolia* E. Wimm. (325, 1277)
L. chamaepitys Lam. (1726)
L. comosa L. (753, 1768)
L. coronopifolia L. (323, 548)
L. erinus L. (1013, 1229)
L. jasionoides E.Wimm. (204)
L. linearis Thunb. (1049, 1128)
L. nuda Hemsl. var. *rosulata* (S.Moore) E.Wimm. (2029)
L. pinifolia L. (300, 333, 562 (a), 1136)
L. pubescens Ait. (1699)
L. setacea Thunb. (1043, 1126, 1771, 2065)
L. stenosiphon (Adamson) E.Wimm. (1808)
L. tomentosa L.f. (1895)
L. valida Bolus (735)
Merciera brevifolia A.DC. (932, 1769)
M. tenuifolia (L.f.) A.DC. var. *azurea* Adamson (1781)
M. tenuifolia (L.f.) A.DC. var. *thunbergiana* Sond. (167)
Monopsis lutea (L.) Urb. (1070, 1827)
Prismatocarpus cordifolius Adamson (Esterhuysen 13674)
P. diffusus A.DC. (1437)
P. nitidus L'Hérit. (2092)
P. sessilis Eckl. ex A.DC. (880, 1035, 1071, 2119)
Roella ciliata L. (754)
R. compacta Schltr. (1073, 1459)
Roella incurva A.DC. (Adamson 4412)
R. maculata Adamson (Pillans 8195)
R. muscosa L.f. (Esterhuysen 9984)
R. psammophila Schltr. (2106)
R. triflora (Good) Adamson (1124)
Siphocodon spartioides Turcz (971)
Treichelia longebracteata Vatke (1398)
Unigenes humifusa (A.DC.) E.Wimm. (1852)
Wahlenbergia cernua A.DC. (978)

CARYOPHYLLACEAE

Silene burchellii Otth. (737)
S. crassifolia L. (1099)
S. undulata Ait. (1679)
Spergularia marginata (DC.) Kitt. (1295, 1773)

CELASTRACEAE

Cassine barbara L. (507, 524, 1843)
C. maritima (Bol.) L.Bol. (1736, 1928)
C. peragua L. (1693)
Hartogia schinoides C.A.Sm. (425, 884, 1462, 2094, 2191)
Maurocenia frangularia (L.) Mill. (1686)
Maytenus acuminatus (L.f.) Loes. (358, 890)
M. lucida (L.) Loes. (1737)
M. oleoides (Lam.) Loes. (1347)
Pterocelastrus rostratus (Thunb.) Walp. (285)
P. tricuspidatus (Lam.) Sond. (1447, 1476)
Putterlickia pyracantha (L.) Endl. (1791)

CHENOPODIACEAE

Arthrocnemum littoreum Moss (Tölken 487)
A. natalense (Bunge ex Ung.-Sternb.) Moss var. *natalense* (2100)
Chenolea diffusa Thunb. (1828)

COMMELINACEAE

Commelina africana L. (de Vos 422)

COMPOSITAE

Alciope lanata DC. (779, 1269)
A. tabularis DC. (184)
Amellus asteroides (L.) Druce (2430)
Anaxeton asperum (Thunb.) DC. var. *asperum* (568, 1119)
A. laeve (Harv.) Lundg. (1215)
A. nycthemerum Less. (185)
Arctotheca calendula (L.) Levyns (1921)
A. populifolia (Berg.) Norl. (1088)
Arctotis acaulis L. (1189, 1846)

Arctotis angustifolius L. (Boucher s.n.)
A. semipapposa (DC.) Lewin (1340)
Aster bergerianus (Less.) Harv. (596)
Athanasia parvifolia L. (997)
A. trifurcata L. (de Vos 812)
Athrixia heterophylla (Thunb.) Less. (645, 1645)
Berkheya barbata (L.f.) Hutch. (647)
Brachylaena neriifolia (L.) R.Br. (364)
Bryomorphe lycopodioides (Sch.Bip.) Levyns (879, 2036)
Castalis nudicaulis (L.) Norl. var. *nudicaulis* (849, 956, 1377)
C. nudicaulis (L.) Norl. var. *graminifolia* (L.) Norl. (601)
Cenia turbinata Pers. (660)
Chrysocoma coma-aures (L.) (459, 930)
Chrysanthemoides monilifera (L.) Norl. (454)
Cineraria geifolia L. (1399, 1669, 1739)
Conyza ivaefolia (L.) Less. (1097(a))
C. pinnatifida (Thunb.) Less. (1057)
C. ulmifolia (Burm.) Kuntze (Taylor 7644)
Corymbium africanum L. (177)
C. cymosum E.Mey. ex DC. (2026)
C. latifolium Harv. (1012, 1222)
C. scabrum L. forma *filiforme* Harv. (717, 810, 1787)
Cullumia setosa (L.) R.Br. var. *setosa* (483)
C. setosa (L.) R.Br. var. *araneosa* Roessl. (976)
C. squarrosa (L.) R.Br. (1598)
Disparago anomala Schltr. ex Levyns (1461)
D. lasiocarpa Cass. (1045, 1446, 1780)
D. laxifolia DC. (720, 1420)
Elytropappus longifolius Levyns (1167)
E. rhinocerotis Less. (Field observation)
Erigeron canadense L. (B40)
Eroeda imbricata (Lam.) Levyns (514, 2095(a))
Euryops abrotanifolius (L.) DC. (297, 789, 1248)
E. indecorus Nord. (Pillans 8335)
E. rupestris Schltr. (1636)
Felicia aethiopica (Burm.f.) L.Bol. & Wolley-Dod subsp. *aethiopica* (de Vos 788)
F. amelloides (L.) Voss (1590)
F. fruticosa (L.) Nichols (525)
Gazania pinnata (Thunb.) Less. (749)
G. serrata DC. (1415)
Gerbera asplenifolia (Lam.) Spreng. (B55)
Gerbera crocea (L.) Kuntze (384, 1273)
G. tomentosa DC. (32, 187)
Gibbaria ilicifolia (L.) Norl. (207)
Gnaphalium candidissimum Lam. (1720)
G. undulatum L. (1463)
Haplocarpha lanata Less. (2747)
Helichrysum argyropsis DC. (657)
H. auriculatum Less. (Taylor 7222)
H. capitellatum (Thunb.) Less. (Scrap collection)
H. crispum (L.) D.Don (927)
H. cymosum Less. (1051)
H. ericaefolium Less. (1082)
H. foetidum Cass. (1112)
H. indicum (L.) Grierson (993)
H. maritimum (L.) D.Don ex G.Don (731)
H. metalasioides DC. (1170)
H. orbiculare (Thunb.) Druce (1052)
H. pinifolium (Lam.) Schrank (182, 895)
H. retortum (L.) Willd. (656)
H. sesamoides (L.) Willd. (634)
H. teretifolium (L.) Less. (606)
H. vestitum (L.) Schrank (721)
Helipterum canescens (L.) DC. (646)
H. gnaphaloides (L.) DC. (952)
H. speciosissimum (L.) DC. (1666)
H. variegatum (Berg.) DC. (2896)
H. zeyheri Sond. (2417, 2179)
Heterolepis aliena (L.f.) Druce (898)
Hippia frutescens L. (586, 917, 1602, 1631)
Hypochoeris radicata L. (780)
Ifloga ambigua (L.) Druce (1401)
Lachnospermum umbellatus (D.Don) Pillans (Taylor 7280)
Leontonyx glomeratus (L.) DC. (443)
L. spathulatus (Thunb.) Less. (1798)
Mairia coriacea H.Bol. (913, 2081)
M. microcephala DC. (954)
M. taxifolia (L.) DC. (34, 147, 771, 1646, 2506)
Metalasia bodkinii L.Bol. (995)
M. brevifolia Levyns (757)
M. cephalotes Less. (18, 51, 2071)
M. confusa Pillans (2031, 2071)
M. lichtensteinii Less. (326)
M. muricata (L.) Less. (1504, 1522)
M. quinqueflora DC. (Barker 6080)
M. riparia Salter (Levyns 5333)
M. seriphiifolia DC. (Stokoe s.n. SAM 61964)
Nidorella foetida (L.) DC. (1834)
Osmitopsis afra (L.) Bremer (Stokoe 6631)
O. asteriscoides (Berg.) Less. (10, 1282)
O. parvifolia (DC.) Hoffm. (9)

Osteospermum ciliatum Berg. (981, 1348)
O. junceum Berg. (842)
O. microcephalum Norl. (1024)
O. polygaloides L. (1667)
O. rotundifolium (DC.) Nord. (791, 1169)
Othonna amplexicaulis Thunb. var. *integrifolia* Harv. (1518)
O. amplexifolia DC. (B45)
O. bulbosa L. (395, 1286)
O. dentata L. (587, 651, 1374)
O. multicaulis Harv. (1270)
O. perfoliata Thunb. (1632)
O. quinquedentata Thunb. (301, 1443)
Phaenocoma prolifera (L.) D. Don (Field observation)
Pulicaria scabra (Thunb.) Druce (1061)
Pteronia camphorata L. (2002)
Senecio arnicaeflorus DC. (1665, 1868)
S. coleophyllus Turcz. (1650, 1651)
S. crassulaefolius DC. (1440)
S. cymbalarifolius (L.) Less. (1414, 1619a, 1815, 1890, 1891)
S. elegans L. (453, 1138, 1892)
S. grandiflorus Berg. (1701)
S. halimifolius L. (928)
S. hastifolius (L.f.) Less. (2233)
S. laevigatus Thunb. (1514)
S. lyratus L.f. (Esterhuysen 30652)
S. maritimus L.f. (1599)
S. matricariaefolius DC. (602, 1926)
S. paniculatus Berg. (1010)
S. pinifolius L. (2130)
S. pubigerus L. (335)
S. rigidus L. (1400)
S. rosmarinifolius L.f. (1009)
S. speciosus Willd. (1243)
S. subcanescens Compton (730, 1378)
S. triqueter Less. (212, 215)
S. umbellatus L. (1662)
S. sp. (1440)
Stoebe aethiopica L. (1630)
S. capitata Berg. (B100, B109)
S. cinerea Thunb. (B52)
S. humilis Levyns (Levyns 5369)
S. incana Thunb. (2177)
S. plumosa Thunb. (1449)
S. sphaerocephala Schlechtd. (1770)
S. spiralis Less. (1161)
S. vulgaris Levyns (Dr. Eicker and students 22)
S. sp. (1500)
Tarconanthus camphoratus L. (1832, B134)
Ursinia crithmoides (Berg.) Poir. (31, 351)
U. dentata (L.) Poir. (138, 1025)
Ursinia eckloniana (Sond.) N.E.Br. (141)
U. quinquepartita (DC.) N.E.Br. (39, 307, 352)
U. sp. (39)

CONVOLVULACEAE

Cuscuta angulata Engelm. (742)
C. nitida E.Mey. (2080)
Falkia repens L.f. (2658)

CORNACEAE

Curtisia dentata (Burm.f.) C.A.Sm. (318, 322, 2078)

CRASSULACEAE

Cotyledon orbiculata L. (1766)
Crassula capensis (L.) Baill. (365, 1857)
C. coccinea L. (1029)
C. fascicularis Lam. (511, 1634)
C. glomerata Berg. (1199)
C. limeolata Soland. (1498)
C. natans Thunb. (628)
C. nudicaulis L. (B102)
C. obtusa Haw. (2044)
C. rupestris Thunb. (1439)
C. tetragona L. (2459)
Dinacria filiformis Harv. (750)

CRUCIFERAE

Heliophila africana (L.) Marais (B44)
H. coronopifolia L. (B70)
H. diffusa (Thunb.) DC. var. *flacca* (Sond.) Marais (Stokoe s.n. SAM 64258)
H. linearis (Thunb.) DC. var. *linearifolia* (Burch. ex DC.) Marais (1098, 1497)
H. longifolia DC. (673)
H. meyeri Sond. (387)
H. pusilla L.f. (1615)
H. scoparia Burch. ex DC. (774)
H. sp. (1948)

CUCURBITACEAE

Kedrostis nana (Lam.) Cogn. (445, 1790)

CUNONIACEAE

Cunonia capensis L. (de Vos 1297)
Platylophus trifoliatus (Thunb.) D.Don. (889)

DIPSACACEAE

Scabiosa columbaria L. (2432)

DROSERACEAE

Drosera aliciae Hamet (819, 1750)
D. cistiflora L. (543)
D. glabripes (Harv.) Stein (4, 54, 180)

Drosera hilaris Cham. & Schlechtd. (652, 790, 1142)
D. trinervia Spreng. (688)

EBENACEAE

Diospyros glabra (L.) de Wint. (595, 2461)
Euclea polyandra (L.f.) E.Mey. ex Hieron. (2123)
E. racemosa Murr. (466, 1502)

ERICACEAE

Acrostemon stokoei L. Guth. var. *confusus* E.G.H.Oliver (1327)
Aniserica gracilis (Bartl.) N.E.Br. (200, 344)
Blaeria barbigera (Salisb.) G.Don. (626, 992)
B. dumosa Wendl. (882, 903, 991, B22)
B. ericoides L. (1159)
B. flexuosa Benth. (1285)
B. sp. (874, 1179)
Erica aemula Guth. & Bol. (555)
E. amphigena Guth. & Bol. (1002)
E. articularis L. (894, 969, 1214)
E. azalaefolia Salisb. (893)
E. banksia Andr. (Oliver s.n. STE 30033)
E. borboniaefolia Salisb. (Rourke 312)
E. brachialis Salisb. (1106, 1535)
E. brevifolia Soland. ex Salisb. (2651)
E. bruniades L. (728)
E. caffra L. (497, 785)
E. calycina L. var. *periplocaeflora* (Salisb.) H.Bol. (135)
E. campanularis Salisb. (410)
E. capillaris Bartl. var. *compacta* H.Bol. (Oliver & Palser 66)
E. cerinthoides L. (765)
E. cinta L. Bol. (Stokoe s.n. BOL 17 201)
E. coccinea L. (290, 580)
E. comptonii Salter (341, 1332, 1501(a))
E. corifolia L. (29, 998, 1030)
E. corydalis Salisb. (202, 148)
E. cristata Dulfer (328, 1027)
E. curviflora (421, 803)
E. curvirostris Salisb. (1135)
E. cygnea Salter (Pillans 8184)
E. desmantha Benth. (134, 1219)
E. discolor Andr. (1147)
E. distorta Bartl. (1510)
E. extrusa Compton (871)
E. fascicularis L.f. (129, 309)
E. fastigiata L. (53, 128, 183, 199, 877)
E. fervida L. Bol. (2897)
E. filiformis Salisb. (975, 1000)
E. foliacea Andr. (37, 131)
Erica genistaefolia Salisb. (194, 1102)
E. georgica Guth. & Bol. (195)
E. gnaphaloides L. (902)
E. gysbertii Guth. & Bol. (11, 96, 747, 1003)
E. hispidula L. (47, 50, 302, 389)
E. holosericea Salisb. (2652)
E. imbricata L. (409)
E. intervallaris Salisb. (150, 308, 784)
E. laeta Bartl. (914)
E. laevigata Bartl. (1421)
E. lananthera L.Bol. (1129(b))
E. leucotrachela H.A. Baker (132)
E. longifolia Ait. (413)
E. lowryensis L.Bol. (M.M. Vogts s.n.)
E. lutea Berg. (904)
E. lycopodiastrum Lam. (B124)
E. macowanii Cufino (133, 201, 407)
E. macroloma Benth. (Haynes 339)
E. mammosa L. (1053)
E. massoni L.f. (Lavranos 8269, Oliver 94)
E. monadelphia Willd. (643)
E. multumbellifera Berg. (1064)
E. nana Salisb. (Oliver s.n. STE 30128)
E. nivea Sinclair (786)
E. nudiflora L. (1182, 1206)
E. obliqua Thunb. (1065, 1150)
E. obtusata Klotzsch ex Benth. (892)
E. pageana L.Bol. (Oliver 3201)
E. palliiflora Salisb. (847)
E. parviflora L. (541, 1145)
E. parvula Guth. & Bol. (292, 340, 1208, 1309, 1523)
E. patersonia Andr. (569)
E. perspicua Wendl. (55)
E. petrophila L.Bol. (878)
E. pillansii H.Bol. (310)
E. pinea Thunb. (Oliver 159, Taylor 7065)
E. placentaeflora Salisb. (613, 872)
E. plukeneti L. (1373, 1488)
E. plumigera Bartl. (546)
E. porteri Compton (1095, 2420)
E. pulchella Houtt. (433, 969)
E. pycnantha Benth. (Taylor 7224)
E. quadrangularis Salisb. (136, 149)
E. retorta Montin (1026, 1129a, 1158)
E. rhopolantha Dulfer (746, 1184)
E. sexfaria Ait. (891)
E. serratifolia Andr. var. *subnuda* H.Bol. (1240, 1330)
E. sessiliflora L.f. (Oliver 142)
E. sitiens Klotzsch (27, 293, 800, 896, 1235, 1329)
E. sonderiana Guth. & Bol. (2248)
E. spumosa L. (1417)

Erica stokoei L.Bol. (346)
E. subdivaricata Berg. (1216)
E. tenax L.Bol. (1453)
E. thomae L.Bol. (28, 1104)
E. transparens Berg. (1328)
E. trichroma Benth. (M.M.Vogts 30)
E. truncata L.Bol. (52, 197)
E. turbiniflora Salisb. var. *aristata* H.Bol. (1223)
E. utriculosa L.Bol. (Oliver 3399, Taylor 7273)
E. vallis-aranearum E.G.H.Oliver (Oliver 1249)
E. velitaris Salisb. (1149, 1165)
E. sp. (1418)
E. sp. (801)
E. sp. (714)
E. sp. (Oliver s.n.)
Nagelocarpus serratus (Thunb.) Bullock (921, 1118)
Philippia chamissonis Klotzsch (Compton 22718)
P. leeana Klotzsch (745)
Salaxis axillaris Salisb. (de Vos 839)
S. flexuosa Klotzsch (766)
Scyphogyne longistyla N.E.Br. (1162)
S. muscosa (Ait.) Steud. (796, 1096)
S. urceolata (Klotzsch) Benth. (1264)
Syndesmanthus elimensis N.E.Br. (1256)
S. paucifolius Benth. (de Vos 263)
Sympieza articulata (Thunb.) N.E.Br. (289)
S. capitellata Licht. (M.M.Vogts 77)
S. labialis (Salisb.) Druce (802)
S. pallescens N.E.Br. (1092)

EUPHORBIACEAE

Adenocline ovalifolia Turcz. (1617)
Clutia alaternoides L. var. *alaternoides* (550, 592, 597, 638, 1633)
C. alaternoides L. var. *major* Krauss (386)
C. ericoides Thunb. (2126)
C. polygonoides L. (13, 383)
C. pterogona Muell. Arg. (799)
Euphorbia erythrina Link. (1390)
E. silenifolia (Haw.) Sweet (510)

FLACOURTIACEAE

Kiggelaria africana L. (1466)

FUMARIACEAE

Phacocapnos cracca Bernhr. (528)

GENTIANACEAE

Chironia baccifera L. (594, 929)
C. decumbens Levyns (2178)
C. jasminoides L. (2431, 2512)
C. linoides L. subsp. *linoides* (962, 1001, 2064)
C. linoides L. subsp. *nana* Verdoorn (577)
C. melampyrifolia Lam. (205)
C. stokoei Verdoorn (2247)
Orphium frutescens (L.) E.Mey. (Rodin 3124)
Sebaea minutiflora Schinz (1950)
S. zeyheri Schinz (488)
Villarsia capensis (Houtt.) Merrill (186, 1654)

GERANIACEAE

Erodium botrys (Cav.) Bertol. (531)
E. incarnatum L'Hérit. (2000)
E. malachoides (L.) Willd. (532)
Geranium flanaganii Schltr. (679)
G. incanum Burm.f. (671, 1869)
Pelargonium angulosum Ait. (473)
P. betulinum (L.) Ait. (521)
P. capillare (Cav.) Willd. (1438)
P. capitatum (L.) Ait. (474, 775)
P. candicans Spreng. (1900)
P. cardiophyllum Harv. (793, 980, 1941)
P. carneum Jacq. (158)
P. chamaedrifolium Jacq. (1785)
P. cucullatum Ait. (1703)
P. grossularioides (L.) Ait. (2425)
P. longifolium (Burm.f.) Jacq. (1487)
P. moniliforme E.Mey. ex Harv. (1186)
P. multicaule Jacq. (1075)
P. myrrhifolium (L.) Ait. (1671, 1945)
P. pinnatum L'Hérit. (961)
P. tabulare (L.) L'Hérit. (1413)
P. triste (L.) Ait. (763)

GESNERIACEAE

Charadrophila capensis Marloth (In reserved area at Betty's Bay)

GRUBBIACEAE

Grubbia linearifolia Gutzweiller (1452)
G. rosmarinifolia Berg. (415)
G. tomentosa (Thunb.) Harms (642)

ICACINACEAE

Apodytes dimidiata E.Mey. (345, 359)

LABIATAE

Leonotis leonurus R.Br. (974)
Salvia aurea L. (463)
Stachys thunbergii Benth. (853)

LAURACEAE

Cassytha ciliolata Nees (1873)
C. filiformis L. (303)
Cryptocarya angustifolia E.Mey. (Taylor 7068)
Ocotea bullata E.Mey. ex Meisn. (2181)

LEGUMINOSAE

Subf. *MIMOSOIDEAE*
Acacia cyclops A.Cunn. (Field observation)
A. longifolia Willd. (1591)
A. mearnsii De Wild. (Field observation)
A. saligna Wendl. (Field observation)
Albizia lophantha (Willd.) Benth. (1318)
Subf. *PAPILIONATAE*
Amphithalea ericaefolia Eckl. & Zeyh. (1237)
A. oppositifolia L.Bol. (B12)
Argyrolobium filiforme Eckl. & Zeyh. (169, 1033, 1782)
A. lunaris (L.) Druce (B110)
A. tuberosum Eckl. & Zeyh. (1525)
Aspalathus abietina Thunb. (1753)
A. acanthiloba Dahlg. (Peterson and Dahlgren 1301)
A. aciphylla Harv. (1193)
A. angustifolia (Lam.) Dahlg. subsp. *angustifolia* (2892)
A. araneosa L. (542)
A. aspalathoides (L.) Dahlg. (752)
A. biflora E.Mey. (561)
A. callosa L. (769)
A. ciliaris L. (1778)
A. cordata (L.) Dahlg. (504)
A. crenata (L.) Dahlg. (558)
A. cymbiformis DC. (Leighton 14228)
A. divaricata Thunb. subsp. *divaricata* (Parker 4371)
A. dunsdoniana Alst. ex Dahlg. (382, 1278, 1458)
A. excelsa Dahlg. (Esterhuysen 31414)
A. globosa Andr. (2438)
A. globulosa E.Mey. (Levyns 10868)
A. forbesii Harv. (620, 1605, B83)
A. fusca Thunb. (1874)
A. hispida Thunb. subsp. *hispida* (1741)
A. intervallaris Bol. (369, 1177)
A. juniperina Thunb. subsp. *juniperina* (Compton 6092)
A. lactea Thunb. subsp. *adelphea* (Eckl. & Zeyh.) Dahlg. (951)
A. linearis (Burm.f.) Dahlg. (966)
A. macrantha Harv. (2176)
A. marginata Harv. (Esterhuysen 13671)
Aspalathus monosperma (DC.) Dahlg. (Stokoe 896)
A. oblongifolia Dahlg. (2464)
A. ramulosa E.Mey. (Porter s.n. BOL 55957)
A. retroflexa L. (1779)
A. sericea Berg. (751)
A. serpens Dahlg. (1685)
A. stenophylla Eckl. & Zeyh. subsp. *colorata* Dahlg. (1089, 1416, 1751)
A. stokoei L.Bol. (Esterhuysen 13678)
A. ternata (Thunb.) Druce (1432)
Bolusafra bituminosa (L.) Kuntze (B128)
Cyclopia genistoides (L.) R.Br. (579, 703)
C. maculata (Andr.) Kies (Harold Porter Botanic Garden No. 69)
C. meyeriana Walp (2654)
Dipogon lignosus (L.) Verde. (821, 1652)
Hypocalyptus coluteoides (Lam.) Dahlg. (1199)
H. oxalidifolia (Sims) Phillips (Davis SAM 61424)
Indigofera angustifolia L. (607, 1684)
I. brachystachya E.Mey. (513)
I. coriacea Ait. (758)
I. cytisoides Thunb. (1473(a), 1851)
I. filicaulis Eckl. & Zeyh. (797)
I. filifolia Thunb. (566, 711, 1176, 1464)
I. glomerata E.Mey. (440)
I. guthriei H.Bol. (2054)
I. hamulosa Schltr. (Dr. Eicker & students 82)
I. humifusa Eckl. & Zeyh. (823)
I. mauritanica (L.) Thunb. (Field observation)
I. ovata Thunb. (710, 805)
I. sarmentosa L. (428)
I. stricta L.f. (897)
I. tetragonaloba E.Mey. (48, 196)
Lathriogyne parvifolia Eckl. & Zeyh. (1306)
Lessertia pulchra Sims (663)
Lebeckia carnosa (E.Mey.) Druce (899, 955, 1981)
L. wrightii (Harv.) Bol. (381, 2175)
Liparia splendens (Burm.f.) J.J.Bos & de Wit subsp. *comantha* (Eckl. & Zeyh.) J.J.Bos & de Wit (Bos 375)
Lotononis prostrata (L.) Benth. (1899)
L. involucrata Benth. (448)
Podalyria calyptrata Willd. (2499)
P. cordata (Taylor 7151)
P. hirsuta (Ait.) Willd. (2058)
P. racemulosa DC. (1906)
P. speciosa Eckl. & Zeyh. (1880, 2040)

Priestleya angustifolia Eckl. & Zeyh. (1881)
P. calycina L.Bol. (1283, 1809)
P. tomentosa (L.) Druce (2150, 2505)
P. vestita DC. (142, 1363)
Psoralea aculeata L. (822)
P. affinis Eckl. & Zeyh. (505)
P. aphylla L. (385, 627)
P. asarina (Berg.) Salter (1050)
P. biovulata Bolus (1181)
P. cordata (L.) Salter (792)
P. fruticans (L.) Druce (907, 939)
P. laxa Salter (B69)
P. obliqua E.Mey. (Rycroft 1453)
P. pinnata L. (206, 1290)
P. repens L. (B91)
P. restioides Eckl. & Zeyh. (1137)
P. zeyheri Harv. (175, 1619, 2023, B57)
Rafnia cuneifolia Thunb. (520, 968)
R. lancea DC. (1039, 1823)
R. perfoliata E.Mey. (759)
R. triflora Thunb. (2050)
Rhynchosia ferulaefolia Benth. (696)
Sutherlandia frutescens (L.) R.Br. (733)
Virgilia oroboides Salter (Harold Porter Botanic Garden no. 73)

LENTIBULARIACEAE

Utricularia capensis Spreng. (372, 817)

LINACEAE

Linum africanum L. (770, 1077, 2030)
L. thunbergii Eckl. & Zeyh. (363)

LORANTHACEAE

Viscum capense L.f. (667)
V. eucleae Eckl. & Zeyh. (1342, 2004)

MALVACEAE

Anisodontea scabrosa (L.) Bates (1389)
Hibiscus trionum L. (1060, 1403)
Lavatera arborea L. (2894)

MENISPERMACEAE

Antizoma capensis (Thunb.) Diels. (B129)

MYOPORACEAE

Myoporum serratum R.Br. (Field observation)
Oftia africana (L.) Bocq. (522)

MYRICACEAE

Myrica cordifolia L. (622)
M. diversifolia Adamson (1349)
M. kraussiana Buching. ex. Meisn. (1907)
M. quercifolia L. (471)
M. serrata Lam. (1055, 1101)

MYRSINACEAE

Myrsine africana L. (529, 637)
Rapanea melanophloeos (L.) Mez. (316)

MYRTACEAE

Eucalyptus ficifolia F.Muell. (1445)
E. lehmannii Preiss. (1317)
Leptospermum laevigatum F.Muell. (1371)
Metrosideros angustifolia J.E.Sm. (1207, 1448)

NAJADACEAE

Aponogeton distachyos L.f. (1227)

OLEACEAE

Linociera foveolata (E.Mey.) Knobl. subsp. *tomentella* Verdoorn (1775)
Olea africana Mill. (1465, 1663)
O. capensis L. subsp. *capensis* (337, 436, 475, 598, 997)
O. exasperata Jacq. (1524)

OLINIACEAE

Olinia cymosa Thunb. (321, 530, 1789)

OXALIDACEAE

Oxalis commutata Sond. (1192)
O. fergusonae Salter (350)
O. glabra Thunb. (1472)
O. heterophylla DC. (1901)
O. incarnata L. (922)
O. luteola Jacq. (1267, 1345, 1509)
O. polyphylla Jacq. (1268)
O. trunculata Jacq. (30)

PENAEACEAE

Penaea cneorum Meerb. subsp. *cneorum* (905)
P. mucronata L. (286, 334)
Saltera sarcocolla Bullock (7, 609)
Sonderothamnus petraeus (W.F.Barker) Dahlg. (722, 787)

PIPERACEAE

Peperomia retusa (L.f.) A.Dietr. (323 (a))

PLANTAGINACEAE

Plantago carnosa Lam. (1083)
P. lanceolata L. (1732)

POLYGONACEAE

Polygonum salicifolium Brouss. ex Willd. (1707)
Rumex angiocarpus Murb. (1601)
R. cordatus Desf. (484, 1367, 2214)

PLUMBAGINACEAE

Limonium scabrum (Thunb.) Kuntze (1048)

POLYGALACEAE

Muraltia alopecuroides (L.) DC. (1637)
M. aspalatha DC. (553)
M. capensis Levyns (1911)
M. chamaepitys Schltr. (795, 1545)
M. ericoides (Burm.f.) Steud. (Stokoe 1204)
M. filiformis (Thunb.) DC. var. *caledonensis* Levyns (989)
M. heisteria (L.) DC. (361, 506)
M. minuta Levyns (1792)
M. mutabilis Levyns (Levyns 9280)
M. paludosa Levyns (Compton 13592)
M. pauciflora (Thunb.) DC. (398)
M. rosmarinifolia Levyns (Leipoldt 4249)
M. satureioides DC. (619, 685, 1512)
M. vulpina Chod. (1546)
Nylandtia spinosa (L.) Dumort (617)
Polygala bracteolata L. (603, 2037)
P. garcini DC. (772)
P. meridionalis Levyns (Compton 20074)
P. myrtifolia L. (461)
P. nematocaulis Levyns (794)
P. pappeana Eckl. & Zeyh. (1783)
P. refracta DC. (de Vos 712)

PRIMULACEAE

Anagallis arvensis L. (1706)
Samolus porosus (L.f.) Thunb. (1597)

PROTEACEAE

Aulax cancellata (L.) Druce (1018, 1280)
A. umbellata (Thunb.) R.Br. (1019)
Brabejum stellatifolium L. (923, 1492(a))
Diastella bryiflora Salisb. ex Knight (343)
D. serpyllifolia Knight (M.M.Vogts 10)
D. sp. (Stehle 250)
Hakea sericea Schrad. (1288)
Leucadendron coniferum (L.) Meisn. (1362, 1511)
L. gandogeri Schinz ex Gand. (338, 1281, 1334)
L. laureolum (Lam.) Fourc. (212, 2184)
L. microcephalum Gand. (2186)
L. salicifolium (Salisb.) Williams (2185)
L. salignum Berg. (515)
L. sessile R.Br. (496, 1660)
Leucadendron spissifolium (Salisb. ex Knight) Williams subsp. *spissifolium* (571, 984)
L. xanthoconus (Kuntze) K.Schum. (283, 1021, 1638)
Leucospermum conocarpodendron (L.) Buek. subsp. *viridum* Rourke (768)
L. cordatum Phillips (563)
L. cordifolium (Salisb. ex Knight) Fourcade (2000 (a))
L. oleifolium (Berg.) R.Br. (417)
L. prostratum (Thunb.) Stapf (625)
L. truncatulum (Salisb. ex Knight) Rourke (1483)
Mimetes argenteus Knight (190, 126, 1324)
M. capitulatus R.Br. (1156)
M. cucullatus (L.) R.Br. (140)
M. hirtus (L.) Salisb. ex Knight (1097, 1866)
M. hottentoticus Phill. & Hutch. (1250, 1806)
(*M. stokoei* Phill. (630) extinct)
Orothamnus zeyheri Pappe (1284)
Paranomus sceptrum-gustavianus (Sparrm.) Hylander (2418)
Protea acaulos (L.) Reich. (1205)
P. angustata R.Br. (B74b)
P. arborea Houtt (1353)
P. cordata Thunb. (1310)
P. cynaroides (L.) L. (1499)
P. grandiceps Tratt. (2118)
P. lepidocarpodendron L. (281, 1287)
P. longifolia Andr. (1320)
P. mundii Klotzsch (282)
P. neriifolia R.Br. (P. van der Merwe 1159)
P. oleracea L.Bol. (1247)
P. repens L. (1291)
P. scabra. R.Br. (426, 1600)
P. speciosa L. (1351)
P. stokoei Phill. (139)
Serruria adscendens R.Br. (518)
S. aemula R.Br. (Harold Porter Botanic Garden No. 41)
S. barbigera Salisb. ex Knight (1635, 1735)
S. burmannii R.Br. (519)
S. elongata R.Br. (633, 702)
S. inconspicua Guth. & Salter (1746)
S. rubricaulis R.Br. (2200)
S. sp. (875, 1745)
Sorocephalus clavigerus (Salisb. ex Knight) Hutch. (1339)
S. palustris Rourke (Rourke 324)
Spatalla curvifolia Salisb. ex Knight (612)

Spatalla longifolia Salisb. ex Knight (1325, 1807)
S. mollis R.Br. (376)
S. prolifera (Thunb.) Salisb. ex Knight (Compton 19407)
S. racemosa (L.) Druce (Stokoe 419)
S. setacea (R.Br.) Rourke (1350, 2116)

RHAMNACEAE

Phylica atrata Licht. ex Roem. & Schult. (391, 840)
P. buxifolia L. (54)
P. ericoides L. (472, 545)
P. humilis Sond. (296)
P. imberbis Berg. (970, 1066, 1110)
P. lasiocarpa Sond. (367)
P. minutiflora Schltr. (Pillans 8260)
P. parviflora Berg. (1537, 1740)
P. plumosa L. (557)
P. spicata L.f. (985)
P. stipularis L. (508, 508 (a))
P. strigulosa Sond. (B101)

RANUNCULACEAE

Anemone capensis L. (146)
Knowltonia capensis (L.) Hutch. (319, 485)

RETZIACEAE

Retzia capensis Thunb. (Field observation)

RORIDULACEAE

Roridula gorgonias Planch. (Guthrie 3765, Stokoe 2656)

ROSACEAE

Cliffortia apiculata Weim. (841)
C. atrata Weim. (648, 2125)
C. complanata E.Mey. (342, 1127)
C. cuneata Ait. (1749)
C. eriocephalina Cham. (2203)
C. ferruginea L.f. (683)
C. filicaulis Schlechtd. (536)
C. graminea L.f. (920)
C. grandifolia Eckl. & Zeyh. (1258)
C. heterophylla Weim. (209)
C. hirsuta Eckl. & Zeyh. (572)
C. odorata L.f. (41)
C. pedunculata Schltr. (Stokoe s.n. (1922))
C. ruscifolia L. (502)
C. strobilifera Murr. (446)
C. subsetacea Diels ex Bol. & W.Dod (783)
C. tenuis Weim. (1234)
C. tuberculata (Harv.) Weim. (2093 (a))
C. viridis Weim. (23, 193)
Rubus fruticosus L. (Field observation)

RUBIACEAE

Anthospermum aethiopicum L. (538)
A. bergianum Cruse (406, 2190)
A. ciliare L. var. *ciliare* (600, 1366)
A. ciliare L. var. *papillatum* Sond. (1134)
A. lichtensteinii Cruse (1238)
A. prostratum Sond. (1197)
Carpococe heteromorpha (Eckl. & Zeyh.) H.Bol. (782, 1623)
C. spermacocea (Reichb.) Sond. (1069, 1144)
C. vaginellata Salter (420)
Galium tomentosum Thunb. (Rourke 704)

RUTACEAE

Acmadenia sp. (1244)
Adenandra acuta Schltr. (715)
A. brachyphylla Schlechtd. (836)
A. uniflora Willd. (734)
A. villosa (Berg.) Licht. ex Roem & Schult. subsp. *villosa* (559, 2055)
A. villosa (Berg.) Licht. ex Roem. & Schult. subsp. *orbicularis* Strid (de la Bat s.n. STE 30300)
A. villosa (Berg.) Licht. ex Roem & Schult. subsp. *robusta* Strid (137)
Agathosma anomala E.Mey. ex Sond. (Stokoe 892)
A. bifida Bartl. & Wendl. (403, 512, 838, 1618, 1717, 1752, 2252)
A. ciliaris (L.) Druce (464)
A. crenulata (L.) Pillans (284)
A. hookeri Sond. (1674, 1887)
A. imbricata Willd. (994)
A. serpyllacea Licht. ex Roem. & Schult. (1297)
A. stokoei Pillans (Stokoe s.n. SAM 60329)
A. tabularis Sond. (636)
Coleonema album Bartl. & Wendl. (462)
C. juniperinum Sond. (125, 649)
C. nubigenum Esterh. (554)
Diosma hirsuta L. (996, 1548)
D. oppositifolia L. (368, 599, 1023, 1047, B86)
Empleurum serrulatum Ait. (1245, 2086)
Euchaetis elata Eckl. & Zeyh. (2482)
E. glabra Williams (1263)
E. linearis Sond. (1230)
Rutaceae (1648)

SALICACEAE

Populus canescens (Ait.) Sm. (Field observation)

SANTALACEAE

Colpoon compressum Berg. (437, 467, 1016, 1087)
Thesidium fragile Sond. (616)
Thesium capitatum L. (844)
T. capitellatum A.DC. (2041)
T. capituliflorum Sond. (562)
T. carinatum A.DC. (713)
T. commutatum Sond. (1007)
T. ericaefolium A.DC. (1122)
T. euphorbioides L. (855, 967)
T. micropogon A.DC. (986)
T. pinifolium A.DC. (Taylor 601)
T. spicatum L. (362, 983, 1079, 1473)
T. strictum Berg. (501, 2005)
T. viridifolium Levyns (1239)
T. virgatum Lam. (544)

SAPOTACEAE

Sideroxylon inerme L. (1375)

SAXIFRAGACEAE

Montinia caryophyllacea Thunb. (588)

SCROPHULARIACEAE

Agathelpis dubia (L.) Hutch. (732)
Alectra lurida Harv. (581)
A. sessiliflora (Vahl) Kuntze (1080)
Dischisma erinoides (L.f.) Sweet (666, 1402)
Halleria elliptica Thunb. (1341)
H. lucida L. (404, 1468)
Harveya bolusii Kuntze (1698)
H. capensis Hook. (1813)
H. coccinea Schltr. (748)
Hebenstreitia cordata L. (2454)
Hemimeris montana L.f. (486, 1364)
Hyobanche sanguinea L. (623)
Manulea cheiranthus L. (756, 2213)
M. rubra L.f. (945)
Melasma luridum Hiern (741)
Nemesia barbata Benth. (527, 621)
N. chamaedrifolia Vent. (533)
N. versicolor E.Mey. (388, 481, 1479)
Selago quadrangularis Choisy (729)
S. scabrida Thunb. (B122)
S. serrata Berg. (1031)
S. spuria L. (848(a), 881, 1436, 1819, 2025, B71)
S. verbenacea Thunb. (388(a))
Sutera hispida (Thunb.) Druce (458, 490)
Teedia lucida Rud. (397)
Zaluzianskya dentata Walp. (615, 736)

SOLANACEAE

Solanum guineense L. (2216)
S. nigrum L. (1469)
S. quadrangulare Thunb. (535, 1086)

STERCULIACEAE

Hermannia hyssopifolia L. (499, 1392, 1393)
H. rudis N.E.Br. (500, 1391)
H. salvifolia L.f. (498, 593, 1394)
H. ternifolia Presl (618, 851, 1616)

THYMELAEACEAE

Cryptadenia breviflora Meisn. (845)
Gnidia anomala Meisn. (835)
G. decurrens Meisn. (Theron & v.d. Schijff 2318)
G. flanaganii C.H.Wr. (1198)
G. galpinii C.H.Wr. (Esterhuysen 10009)
G. humilis Meisn. (1830)
G. juniperifolia Lam. (1338, 1543, 2034)
G. oppositifolia L. (192, 442)
G. penicillata Licht. ex Meisn. (1628)
G. pinifolia L. (366, 438)
Lachnaea densiflora Meisn. (567, 846, 1368, 1767)
Passerina ericoides L. (1691)
P. paleacea Wikstrom (468, 470)
P. rigida Wikstrom (469, 1690)
P. vulgaris Thoday (761)
Struthiola ciliata (L.) Lam. (1356(a), 1072)
S. dodecandra (L.) Druce (1629)
S. eckloniana Meisn. (Dr. Eicker & students no. 19)
S. erecta L. (509)
S. epacridioides C.H.Wr. (1299)
S. leiosiphon Gilg. (1810, 2061, 2117)
S. leptantha H.Bol. (578)
S. myrsinites Lam. (2051, 2211)
S. striata Lam. (de Vos 1212)
S. tomentosa Andr. (837)
S. virgata L. (126)

UMBELLIFERAE

Apium graveolens L. (1831)
Arctopus echinatus L. (1379)
Centella affinis (Eckl. & Zeyh.) Adamson (1358)
C. calliodes (Cham. & Schlechtd.) Drude (1225)
C. caespitosa Adamson (2035)
C. cariacea Nannfd. (B132)

Centella difformis (Eckl. & Zeyh.) Adamson (604)
C. eriantha (Rich.) Drude (919)
C. macrocarpa (Rich.) Adamson (906, 1544)
C. restioides Adamson (933)
C. scabra Adamson (564)
C. triloba (Thunb.) Drude (127, 556)
C. tridentata (L.f.) Drude (1042)
Chamarea capensis (Thunb.) Eckl. & Zeyh. (1477)
Foeniculum vulgare Mill. (589)
Glia gummifera (L.) Sond. (1470)
Hermas ciliata L.f. (1279)
H. depauperata L. (Dr. Eicker & students 43)
H. quercifolia Eckl. & Zeyh. (924, 1143)
H. villosa (L.) Thunb. (210, 1132)
Heteroptilis suffruticosa (Berg.) Leute (843)
Lichtensteinia lacera Cham. & Schlechtd. (1046, 1818)
Peucedanum galbaniopse Wolff (Taylor 7647)
P. multiradiatum Drude (2435)
P. sieberianum Sond. (1133)
Thunbergiella filiformis (Lam.) Wolff (371)

URTICACEAE

Australina lanceolata (Thunb.) R.Br. (1738)
Droguetia ambiqua Wedd. (678)

VERBENACEAE

Campylostachys cernua Kunth (973)
Lantana camara L. (2744)
Stilbe ericoides L. (130, 565, 1174)
S. mucronata N.E.Br. (1242)
S. vestita Berg. (208, 379)

VIOLACEAE

Viola decumbens L.f. var. *decumbens* (401, 419)
V. decumbens L.f. var. *scrotiformis* (DC.) Jessop (Kruger 788)

ZYGOPHYLLACEAE

Zygophyllum fulvum L. (480)
Z. flexuosum Eckl. & Zeyh. (684)
Z. spinosum L. (762)

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'N ANATOMIESE ONDERSOEK VAN DIE BLOM VAN *STRELITZIA REGINAE* BANKS

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Uittreksel

'n Anatomiese ondersoek van die blom van *Strelitzia reginae* is gedoen. Huidmondjies met goedontwikkelde hulpselle kom net in die abaksiale epidermis van die bloeiskede voor. Die grondweefsel bestaan hoofsaaklik uit dunwandige parenchiem met die uitsondering van die styl waar dit uit dikwandige verhoute selle bestaan. Na aanleiding van die vaatpatroon van die blom vertoon dit dat die onderstandige vrugbeginsel appendikulêr in oorsprong is.

Abstract

AN ANATOMICAL INVESTIGATION OF THE FLOWER OF *STRELITZIA REGINAE* BANKS

An anatomical investigation of the flower of *Strelitzia reginae* has been carried out. Stomata with well developed subsidiary cells occur only in the abaxial side of the spathe. The ground tissue consists mainly of thin walled parenchyma with the exception of the style where it consists of lignified thick walled cells. With reference to the vascular pattern of the flower it shows that the inferior ovary is appendicular in origin.

Inleiding

Literatuur aangaande *Strelitzia reginae* handel hoofsaaklik oor die anatomie van die vegetatiewe organe. Solereder en Meyer (1930) gee 'n kort opsomming van wat destyds reeds bekend was oor die algemene anatomiese kenmerke van die blaar, stingel en wortel.

Tomlinson (1969), wat die plant as een van die Strelitziaceae klassifiseer, gee ook 'n kort samevatting van die anatomiese kenmerke van die vegetatiewe organe.

In die huidige ondersoek is 'n poging aangewend om die leemte, in verband met die blomanatomie, aan te vul.

Materiaal en Metodes

Blomme van geïdentifiseerde plante is goedgunstiglik verkry van die Nasionale Botaniese Tuine te Kirstenbosch.

F.A.A. (Johansen, 1940) is deurgaans gebruik as fikseermiddel en het bevredigende resultate gelewer. Vir die dehidrasie en infiltrasie is paraffienwas, etielalkohol en xilol gebruik.

Ontkleuring van blomme is as volg gedoen:

(1) Kook vir 3 minute.

(2) Ontkleur vir 2 dae in peroksied-ammoniak (Johansen, 1940).

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(3) Verhard vir 12 uur in 95% alkohol.
(4) Butielalkohol vir 2 uur, herhaal 2 keer.
(5) Gelyke dele butielalkohol en xilol vir 2 uur.
(6) Suiwer xilol.

Dwarssneë, 16μ dik, is met 'n handrotasiemikrotoom gemaak. Safranien in kombinasie met vaste groen is deurgaans as kleurstowwe gebruik en het bevredigende resultate gelewer.

Die gewone histochemiese reagense is gebruik vir die toets van kalsiumoksalaat- en silikakristalle, tannien en stysel.

Mikrofoto's is geneem met 'n Wild-plaatkamera (6,4 cm × 8,9 cm).

Sketse is met behulp van 'n Wildtekenbuis gemaak.

In die ondersoek is net van dwarssneë gebruik gemaak.

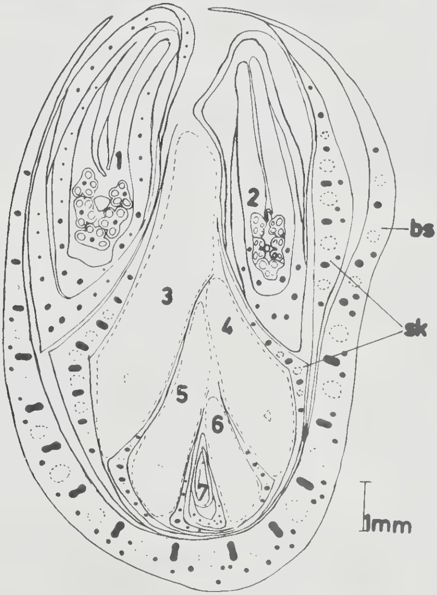


FIG. 1.
Bloeiwyse diagram van *S. reginae*. bs, bloeiskede wat sinsinus omring. sk, skutblaar 1–7, indivuduele blomme met No. 7 as die jongste.

BLOMMORFOLOGIE (Fig. 1 en 7H)

Die bloeiwyse, bekend as 'n sinsinus bestaan uit 'n hele aantal blomme. Dit ontstaan in die oksel van 'n groot bloeiskede wat die verkorte hoofas omsluit. Die blomme is sigomorf en tweeslagtig. Die kelkblare is vry. Die onewe kelkblaar is skuins weg van die hoofas na buite gerig. Die laterale kroonblare is versmelt en vorm 'n breë pylvormige struktuur wat die vyf vrugbare meeldrade omsluit. Die derde kroonblaar is kort en breed. Die vrugbeginsel is onderstandig en driehokkig. Die vrug is 'n doosvrug, hokverbrekend en bevat baie sade op die sentrale plasenta.

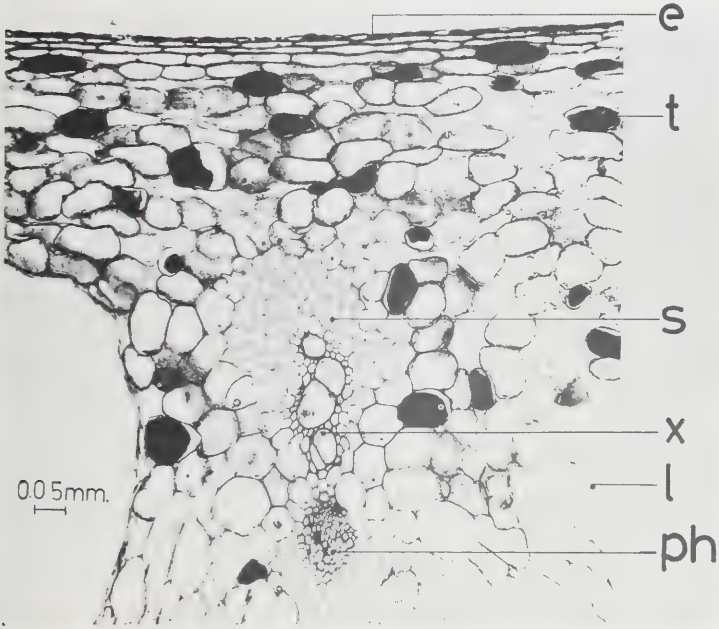


FIG. 2.
Dwarssnee deur die adaksiale gedeelte van die bloeiskede. e, epidermis; l, lugkanaal; ph, floëem; s, sklerenchiem; x, xileem; t, tannienidioblast.

BLOEISTEEL

Die epidermis is een sellaag breed. Die selwande is effens verdik en die buitewande word deur 'n kutikula bedek. Geen epidermale hare kom voor nie. Versonke huidmondjies is hier en daar aanwesig.

Die buitenste drie sellae van die grondweefsel differensieer as 'n hipodermis. Dit bestaan uit baksteenvormige selle waarvan sommige 'n tannieninhoud bevat. Die grootste gedeelte van die grondweefsel bestaan uit dikwandige parenchiemselle met 'n digte protoplasmatiese inhoud. Talryke chloroplaste kom in die selle voor. Ander selle bevat 'n tannieninhoud. Styselkorrels wat dig opmekaar gepak is kom ook voor. Die intersellulêre ruimtes is klein.

Talryke vaatbundels van verskillende grootes lê verspreid in die grondweefsel. Die groot vaatbundels, wat uit 5 tot 8 xileem-elemente en 'n groot hoeveelheid floëem-elemente bestaan kom na binne voor terwyl die kleiner vaatbundels, wat uit 7–9 floëem-elemente en 1 tot 2 xileemelemente bestaan, na aan die omtrek van die bloeisteel lê. 'n Skede van sklerenchiemvesels kom rondom elke vaatbundel voor. Die wande van hierdie vesels word deurkruis met eenvoudige stippelkanale. Sommige van hierdie selle is tannien-bevattend, ander bevat stysel of silikakristalle.

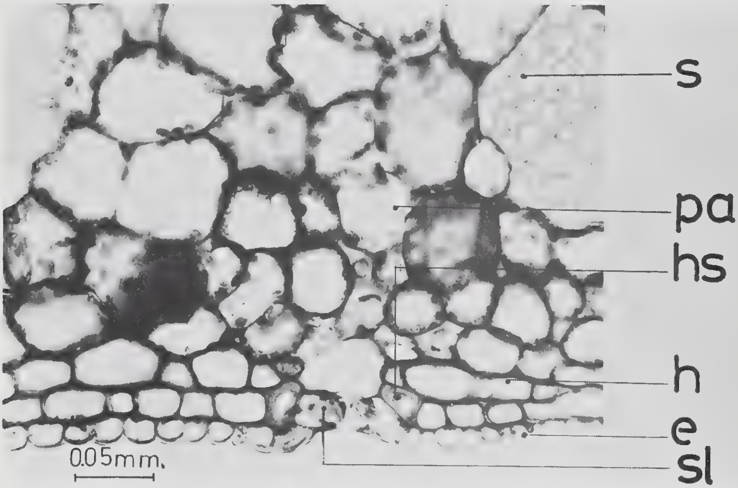


Fig. 3.
Dwarssnee deur die abaksiale gedeelte van die bloeiskede wat 'n huidmondjie aantoon. e, epidermis; h, hipodermis; hs, dikwandige hulpsel; s, sklerenchiembundel; pa, parenchiem met chloroplaste; sl, sluitsel.

Bloeiskede (Fig. 2 en 3)

Selle van die adaksiale epidermis is transversaal afgeplat en kleiner as die van die abaksiale epidermis. Sommige van die adaksiale epidermisselle besit 'n tannieninhoud terwyl die selle van die abaksiale epidermis 'n digte protoplasmatiese inhoud bevat. Kristalidioblaste kom ook in die abaksiale epidermis voor. Die buitenste wande van die abaksiale epidermis is konveks en word deur 'n kutikula bedek.

Die stomata is van die tetrasiet tipe. Twee kort terminale hulpselle asook twee dieper liggend laterale hulpselle omring elke stoma. 'n Gemiddelde telling van die aantal huidmondjies op die adaksiale en abaksiale vlak toon dat daar onderskeidelik 2 en 20 per mm^2 voorkom. Die laterale hulpselle by die adaksiale huidmondjies is dunwandig. Die hulpselle en sluitselle lê op dieselfde vlak as die naasliggende epidermisselle. Die groot sluitselle van die abaksiale stomata lê effens versink onder die epidermisvlak. Twee ewe-groot uitstaande kutikulahorings kom by elke sluitsel voor. Die hulpselle van die abaksiale huidmondjies vertoon driehoekig en aansienlik dikwandig. Die substomatêre ruimte word gevorm deur die hipodermis en parenchiemselle van die grondweefsel.

'n Hipodermis, twee sellae breed, kom onder die abaksiale epidermis voor. Selle van die buitenste laag is isodiametries terwyl die van die binneste laag groot en transversaal afgeplat is.

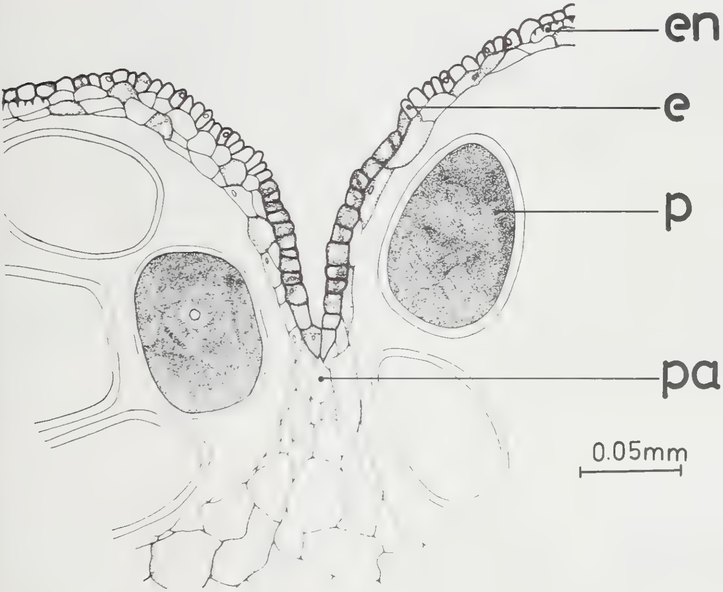


FIG. 4.
Dwarssnee deur 'n gedeelte van die helmknop net voor oopbreking. e, epidermis; en, endotesium; p, stuifmeelkorrel; pa, parenchiem.

Die grondweefsel bestaan uit dunwandige parenchiemselle waarvan slegs sowat 10–12 lae aan die abaksiale kant chloroplaste bevat. Tannien en silikakristalle word afsonderlik aangetref in strukturele onveranderde selle van die grondweefsel. Ovaalvormige styselkorrels kom volop in die parenchiem van die grondweefsel voor.

In die adaksiale gedeelte van die bloeiskede kom groot lengteverlopende lugkanale voor.

Tussen die lugkanale verloop groot Scitamineae-tipe vaatbundels. Twee tot drie klein xileemelemente lê teenaan die floëem, die ander xileemelemente is groot en dikwandig. Sommige van die floëemelemente besit 'n tannieninhoud. Hierdie vaatbundels word in die adaksiale gedeelte van die bloeiskede aangetref.

Kleiner vaatbundels kom aan die abaksiale kant van die bloeiskede voor. 'n Groot hoeveelheid sklerenchiemvesels kom aan die buitekant van die floëem voor. Klein sklerenchiemgroepies kom verspreid naby die abaksiale epidermis voor.

KELK- EN KROONBLAAR

Die epidermisselle is klein en transversaal afgeplat. Hierdie selle het 'n digte protoplasmatiese inhoud. 'n Gemiddelde telling van die huidmondjies toon dat daar onderskeidelik 3 en 18 per mm^2 op die adaksiale en abaksiale vlak voorkom. Die hipodermis is een tot twee sellae breed. Die selwande van die abaksiale hipodermis is dikker as dié van die adaksiale hipodermis.

Die grondweefsel bestaan uit dunwandige parenchiem met klein intersellulêre ruimtes. Tannien- asook kalsiumoksalaatidioblaste kom ook in die grondweefsel voor.

HELMKNOP (Fig. 4)

Die epidermisselle is blywend en bestaan uit groot selle. In die omgewing van die stomium is hulle dikwandig en bevat 'n digte protoplasmatiese inhoud. 'n Goed ontwikkelde endotesium is aanwesig. Esau (1965) sê dat die endotesium sekondêre wandverdikkings in die antiklinale en binneste tangensiale wande by volwassenheid ontwikkel. By *S. reginae* is gevind dat die antiklinale en buitenste tangensiale wande van die endotesium naaste aan die stomium sekondêre wandverdikkings toon. Ander endotesiumselle toon sekondêre verdikkings in hul antiklinale, buitenste- en binneste tangensiale wande.

Die stomium is 'n lengte verlopende spleet en is geleë tussen die voorste en agterste stuifmeelsakke. Op die plek waar breking plaasvind is die parenchiem gereduseer tot 'n smal strook. Ten tye van oopbreking van die stuifmeelsakke vertoon die parenchiemselle, wat weerskante van die vaatbundel lê, spiraalvormige verdikkings soortgelyk aan dié van die endotesium.

Die vaatbundel is sonder 'n skede. Die stuifmeelkorrels is groot. Die volwasse stuifmeelkorrels het 'n digte protoplasmatiese inhoud en het 'n dik eksien, maar 'n dun intien. Die eksien is glad en geen kiemporie is waargeneem nie.

STYL (Fig. 5)

Die epidermisselle is radiaal afgeplat en het dik verhoute wande met 'n klein sellumen. Die grondweefsel bestaan uit dikwandige verhoute selle met klein intersellulêre ruimtes. Tannienidioblaste kom verspreid tussen hierdie selle voor.

Drie klein vaatbundels bestaande uit 6 tot 9 xileemelemente en 'n klein groepie floëemelemente, kom in die grondweefsel voor.

Die styl is hol en stempelweefsel, soos deur Esau (1965) bespreek, ontbreek. Die binneste epidermis bestaan uit radiaal afgeplatte selle. Hulle is dikwandig maar nie verhout nie en besit 'n digte protoplasmatiese inhoud.

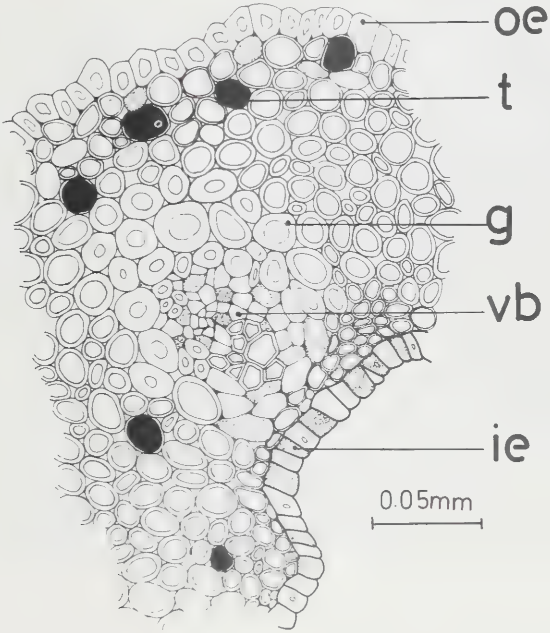


FIG. 5.
Dwarssnee deur die styl. oe, buitenste epidermis bestaande uit dikwandige verhoute selle; ie, binneste epidermisselle met 'n digte protoplasmatiese inhoud; g, grondweefsel bestaande uit verhoute selle; t, tannienidioblast; vb, vaatbundel.

VRUGBEGINSEL EN SAADKNOP (Fig. 6)

Die epidermisselle is klein en besit 'n protoplasmatiese inhoud met groot kerne.

'n Eenlagige hipodermis lê onder die epidermis. Aan die binnekant van die hipodermis volg losgerangskikte dunwandige parenchiemselle. Sommige van hierdie selle bevat tannien, ander kalsiumoksalaat of stysel. Aan die kant van die vrughok kom 'n paar lae klein, diggepakte parenchiemselle voor. Die vrughok word met 'n dunwandige epidermis uitgevoer.

Goed ontwikkelde xileem- en floëemelemente kom in die plasenta voor. Groot hoeveelheid anatrope saadknoppe kom op die binneste hoek van elk van die drie saadhokke voor. Die saadknop het 'n dik buitenste en 'n dun binneste integument, laasgenoemde is aansienlik dikker by die poortjie. Die saadknop is van die krassi-nusellaat tipe. Die nusellus bestaan uit klein dunwandige selle. Xileemelemente eindig in die chalaza.

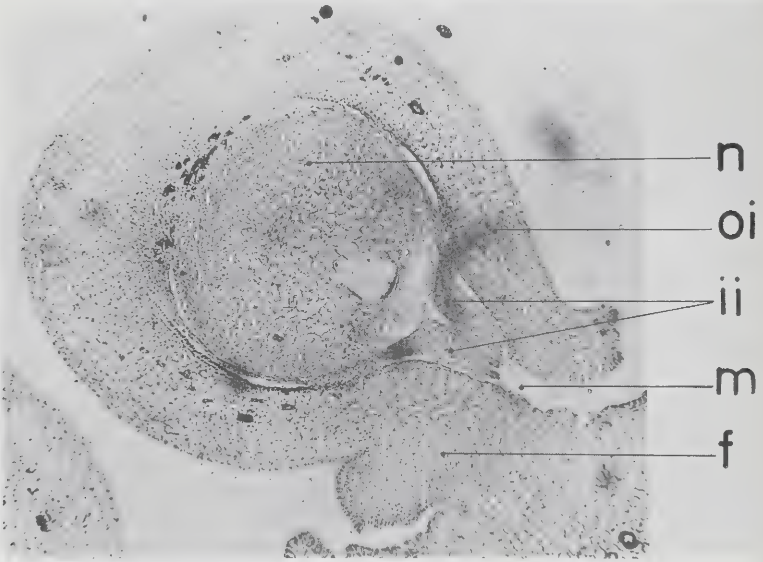
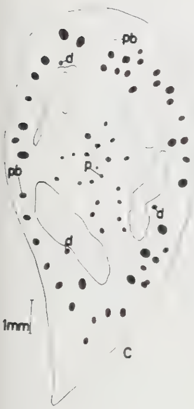


FIG. 6.
Dwarssnee deur die anatrope saadknop. f, naelstring; ii, binneste integument; oi, buitenste integument; m, poortjie; n, nusellus.

DIE VAATANATOMIE VAN DIE BLOM (Fig. 7)

Volgens Kaplan (1967) kan die meerderheid van blomme met onderstandige vrugbeginsel anatomies geïnterpreteer word deur die appendikulêr teorie. Hierdie teorie beweer dat die buitenste blomkranse in die vrugbeginselgebied met mekaar asook met die wand van die vrugbeginsel geadneer het. Soos die vaatsisteem in die vrugbeginsel opwaarts verloop, vind vertakking van vaatweefsel, na die aanhangsels, in 'n akropetale volgorde plaas.

FIG. 7.
A–I, Vaatanatomie van die blom. A–H, Dwarssnee deur byna volwasse blom net voor antese. I, ontkleurde blomdeel wat die verloop van vaatweefsel aantoon asook waar snitte gemaak was. bs, blomsteelvaatbundel; d, dorsale vrugblaarbundel; k, kelkblaarbundel; kr, kroonblaarbundel; mb, meeldraadbundel; ob, vrugbeginselbundel; p, plasentabundel; pb, periantbundel; sb, stylbundel; sv, saadknopvaatstring.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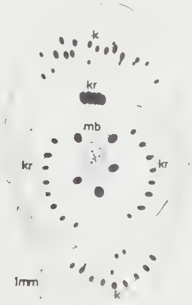
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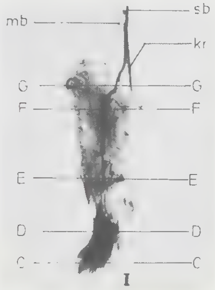
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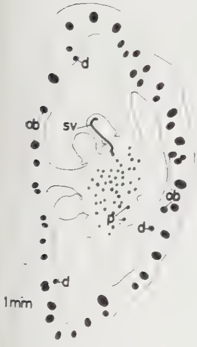
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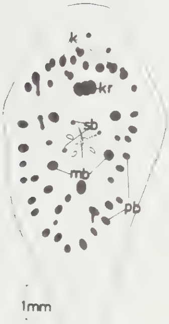
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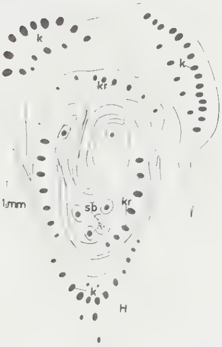
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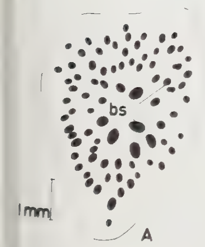
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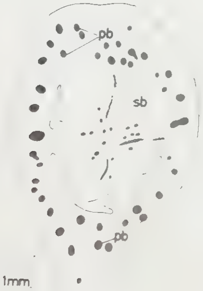
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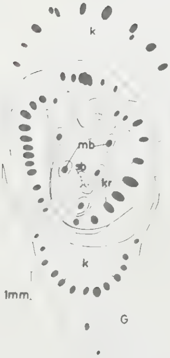
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G

Die vaatanatomie van *S. reginae* word geïllustreer m.b.v. konvensionele sketse van dwarssneë van 'n blom net voor antese. Die hoogte van die verskillende snitte wat gemaak is word in Fig. 7.1 geïllustreer. Die sentraal geleë vaatbundels van die blomsteel is groter as die wat op die omtrek geleë is.

Eersgenoemde vaatbundels verloop in die plasenta waar dit vertak om 'n groot aantal plasentabundels vorm. Oorkant elke saadknop vertak die plasentabundel om 'n saadknopvaatstring te vorm (Fig. 7B). Die kleiner blomsteelvaatbundels anastomeer en dring die wand van die vrugbeginsel binne. Kaplan (1967) verwys na hierdie vaatbundels as die vrugbeginselbundels.

Op die hoogte waar hokvorming begin kan die dorsale vrugblaarbundels onderskei word. Die drie stylbundels is verlengings van die dorsale vrugblaarbundels. In twee gevalle is gevind dat vier bundels in die styl aanwesig is. In die stigma vertak en anastomeer die stylbundels.

Aan die bo-punt van die vrugbeginsel vertak die vrugbeginselvaatbundels om die periantbundels te vorm. Die vyf meeldraadbundels is op hierdie hoogte duidelik sigbaar en ontstaan na binne terwyl die periantbundels in die hipantium verloop. Die onewe-kroonblaar se vaatbundels vertak vanaf die gepaarde kelkblaarbundels (Fig. 7E). Op hierdie hoogte kan die ander kelk- en kroonblaarbundels nog nie onderskei word nie. Op die hoogte waar vertakking van vaatbundels, wat die gepaarde-kelkblare binnedring, plaasvind is die vaatbundels van die onewe-kelkblaar en gepaarde kroonblare reeds sigbaar.

BESPREKING

Die epidermis is dikwandig en wissel van transversaal tot radiaal afgeplat.

'n Gemiddelde telling van die huidmondjies toon dat daar onderskeidelik 2 en 20 per mm^2 op die adaksiale en abaksiale vlak van die bloeiskede voorkom. Dikwandige verhoute hulpselle kom in die abaksiale vlak van die bloeiskede voor.

Die hipodermis, waar aanwesig, wissel van een tot twee sellae. 'n Hipodermis ontbreek onder die abaksiale epidermis van die bloeiskede asook in die vrugbeginsel.

Die grondweefsel bestaan uit dunwandige parenchiemselle maar die van die styl is dikwandig en verhout. Kalsiumoksalaat-, silika-, tannien- en styselbevattende selle kom in die grondweefsel voor.

In die adaksiale gedeelte van die bloeiskede kom groot parallel verlopende lugkanale voor. Tussen die lugkanale lê groot Scitamineae- tipe van vaatbundels.

Die styl is hol en stempelweefsel ontbreek.

Na aanleiding van die vaatpatroon van die blom vertoon dit dat die onderstandige vrugbeginsel van *S. reginae* appendikulêr in oorsprong is.

DANKBETUIGING

My hartlike dank aan die Direkteur van die Nasionale Botaniese Tuine te Kirstenbosch van wie ek materiaal ontvang het en aan Prof. K. J. Pienaar vir die oorlees van die manuskrip.

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Jl S. Afr. Bot. 43 (1): 93–95 (1977)

PASPALUM VAGINATUM SUBSP. *NANUM*. A NEW STATUS

A. E. Loxton

Doell in Mart. F1. Bras.**2**,2: 75 (1877) based his description of *Paspalum vaginatum* Swartz var. *nanum* on a specimen, *Glaziou 4346*, collected near Rio de Janeiro in Brazil. Stapf (1900), maintained that the variety *nanum* also occurred in South Africa, citing only one specimen, *Wolley-Dod 2343*, collected on the Camps Bay shore in the Cape.

Chase (1929), in her revision of the North American Species of *Paspalum*, sinks the variety *nanum*, considering it to be an ecotype of *P. vaginatum*.

In a more recent work, Loxton (1974), mention was made of a few specimens cited by Launert (1970), which do not fit the description of either *P. vaginatum* or *P. paspalodes*. Differences in spikelet dimensions and of geographical distribution distinguish these specimens from the closely related *P. vaginatum*.

The spikelet lengths of this group of specimens range from 2,1–2,3 mm while those of *P. vaginatum* vary from 3,6–4,0 (4,5) mm.

From present distributon records this taxon has only been recorded from the south western Cape and South West Africa, growing under saline conditions along the coast (Fig. 1.) In two instances, however, it has been cultivated inland in South West Africa.

A noteworthy specimen, *Moses s.n.*sub NH *23442*, collected in Cape Town and cultivated at Umbogintwini in Natal, maintained its spikelet dimensions although the plant is vegetatively more robust.

The evidence based on spikelet dimensions and also of geographical distribution necessitates the following change in status:

Paspalum vaginatum Swartz subsp. **nanum** (Doell) Loxton stat. nov.

Paspalum vaginatum var. *nanum* Doell in Mart. F1. Bras. **2**, 2:75 (1877)

Paspalum distichum var. *nanum* Doell, Stapf in F1. Cap. **7**:371 (1900)

Type—Near Rio de Janeiro, *Glaziou 4346*, (P, syn.!)

MATERIAL EXAMINED

S.W.A.—2116 (Okahandja) : Farm Thorn Tree (-DD), *Pretorius s.n.* (WIND).

—2214 (Walvis Bay) : Swakopmund, Swakop River mouth c. O,8 km from coast (-DA), *Van Vuuren 987* (PRE): Swakop River mouth, *Research Station Gobabeb 00102* (PRE).

—2217 (Windhoek) : garden in Windhoek (-CA), *De Winter 6068* (WIND).

—2314 (Sandwich Harbour) : Kuiseb River c. 12 km from Walvis Bay, (-BD), *De Winter 3185*(PRE).

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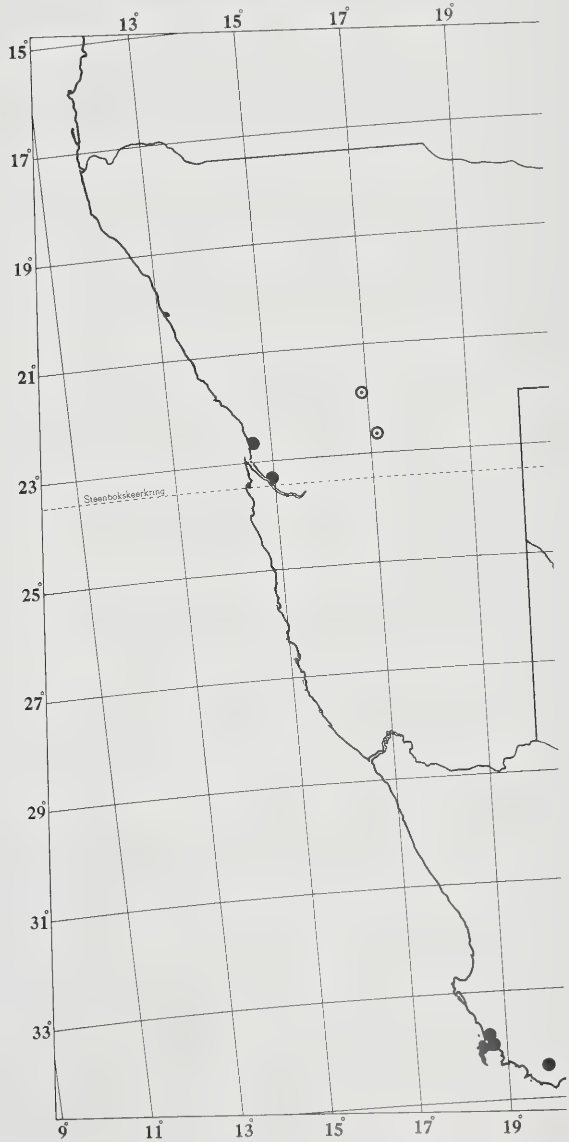

FIG. 1.

Distribution of *Paspalum vaginatum* subsp. *nanum*. ⊙ Records from cultivation.

CAPE—3318 (Cape Town) : Cape Town (-CD), sub PRE 299, Camps Bay shore, *Wolley-Dod 2343* (PRE).
—3418 (Simonstown) : Prinses Vlei (-AB), *Mathews 8214* (PRE); Krom River Lagoon, *Taylor 7052* (PRE); Fish Hoek near Clovelly, *Crook 1045* (PRE); Zeekoe Vlei (-BA), *Wilman 217* (PRE); Ronde Vlei, *Adamson 799* (PRE).
—3419 (Caledon) : Rooi Els (-BD), *Parker* sub PRE *34351*.

NATAL—3030 (Port Shepstone) : cultivated at Umbogintwini, plants from Cape Town (-BB), *Moses* sub NH *23442*.

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Jl S. Afr. Bot. 43 (1): 97–102 (1977)

CHROMOSOME ASSOCIATIONS IN ONION ROOT TIP NUCLEI

D. J. Mogford

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Abstract

Fluorescence analysis of *Allium cepa* nuclei has provided evidence for an ordered arrangement of chromosomes during interphase. In addition it is shown to be heterochromatin that is involved in the end-to-end association of chromosomes that has been observed during prophase, and it is therefore suggested that one function of this type of chromatin may be the maintenance of an ordered chromosome arrangement between cell divisions.

Uittreksel

CHROMOSOOM ASSOSIASIES IN DIE UI WORTELPUNT KERNE

Fluoresserende analises van *Allium cepa*-kerne lewer bewyse vir die ordelike rangskikking van chromosome gedurende interfase. Daar word ook getoon dat heterochromatien betrokke is by die kop aan kop assosiasie van chromosome wat gedurende die profase waargeneem is, en word dit voorgestel dat een funksie van die tipe chromatien die behoud van 'n ge-ordende chromosoomrangskikking tussen seldelings is.

Introduction

It has been known for some time that certain regions of chromosome differ from the remainder in their condensation cycle, being represented variously as bands in metaphase chromosomes and as condensed "chromocentres" in interphase nuclei. Regions of chromosome showing such behaviour are termed "allocyclic" or "heterochromatic". During recent years great attention has been devoted to these regions, following the discovery by Caspersson *et al.* (1968) that they show differential fluorescence after treatment with certain dyes and irradiation by ultraviolet light, and the observations of Pardue and Gall (1970) that they may be differentially stained with Giemsa following a denaturation-reannealing treatment.

In this investigation, following the techniques of Vosa and Marchi (1972) and Vosa (1973), a combined denaturation-reannealing-fluorescence method was used to study chromosomal arrangements in onion nuclei during interphase and early prophase.

Material and Methods

Root tips of *Allium cepa* var. "Ailsa Craig" were pretreated in 0,1% colchicine for 4–5 hours at room temperature, fixed in 3:1 ethanol : glacial acetic acid

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overnight, and hydrolysed in 0,2N HCl at 60° C for 2½ minutes. This was followed by squashing in 45% acetic acid under an albumenised coverslip, the coverslip then being floated off in absolute alcohol, air dried, immersed in saturated barium hydroxide for 5 minutes at room temperature, and incubated in 2 × saline sodium citrate for 30 minutes at 60° C. The coverslip was then washed, air dried, stained for 5 minutes in a benzimidazole derivative (Hoechst 33258–0,1% in absolute alcohol) and observed using a Zeiss ultraphot microscope with an exciter filter BG12 and barrier filter 50.

RESULTS

While other studies, employing Giemsa have indicated the presence of both terminal and centromeric heterochromatin in this species (Mogford, unpublished data; Vosa, in prep.), the present method demonstrates principally the terminal heterochromatin. Terminal heterochromatin was present on all the chromosomes, and, in particular, constituted the highly fluorescent satellites possessed by one chromosome pair (Fig. 1).

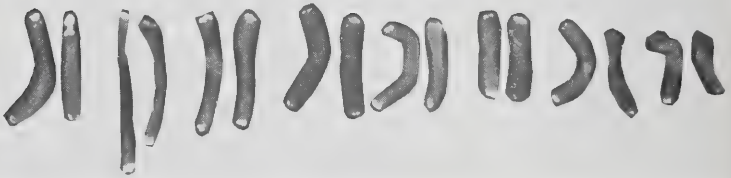

FIG. 1.
The chromosome complement of *Allium cepa*, following the fluorescence technique described in text. Note the highly fluorescent satellites of the first chromosome pair. X1250.

Examination of interphase nuclei indicates that the terminal heterochromatic regions are largely grouped on one side of the nucleus (Fig. 2). Examination of a given cell by both fluorescence and phase contrast indicates that the fluorescent regions do not correspond to any phase-retarding bodies, while examination of early prophase nuclei indicates that in several instances chromosomes are attached terminally at this stage.

DISCUSSION

The observation that the regions of terminal heterochromatin do not correspond to those of any phase-retarding bodies implies that the presence of denser regions in resting nuclei may not be considered a definitive criterion for the presence of heterochromatin.

The grouping of terminal regions at one side of the interphase nucleus is consistent with the expected pattern of chromosome alignment at the previous telophase. Other evidence of an ordered pattern of chromosomes in interphase nuclei exists, the principal being the evidence for an ordered arrangement of chromosomes in the head of the human sperm (Barlow and Vosa, 1970).

The observation that the terminal regions of the chromosomes are heterochromatic and that it is these regions which show fusion at early prophase, throws new light on the striking observation of Wagenaar (1969) that at this stage the chromosomes in this species may be present as a continuous chain, with presumably the homologous chromosomes joined end-to-end. It is clearly a possibility that the formation of terminal attachments, which were interpreted by Wagenaar as being concerned with the maintenance of chromosome arrangement during interphase, may be one of the functions of heterochromatin.

It should be pointed out that the heterochromatic regions revealed by the above technique are thought to contain highly repetitive DNA, which by virtue of such repetition alone would tend to reanneal together during the incubation in buffer following barium treatment. However, Wagenaar's observations on terminal associations in acetic-orcein and Feulgen squashes would imply that such fusions are not solely an artefact of the denaturation-reannealing treatment.

It should also be pointed out that because of the differences in length of non-homologous chromosomes, it would be expected from the telophase arrangement alone that it would be homologous chromosomes which attach preferentially to each other. This, however, solely suggests a mechanism for the formation of such terminal attachments and does not necessarily deny their possible adaptive significance along the lines suggested above.

ACKNOWLEDGMENTS

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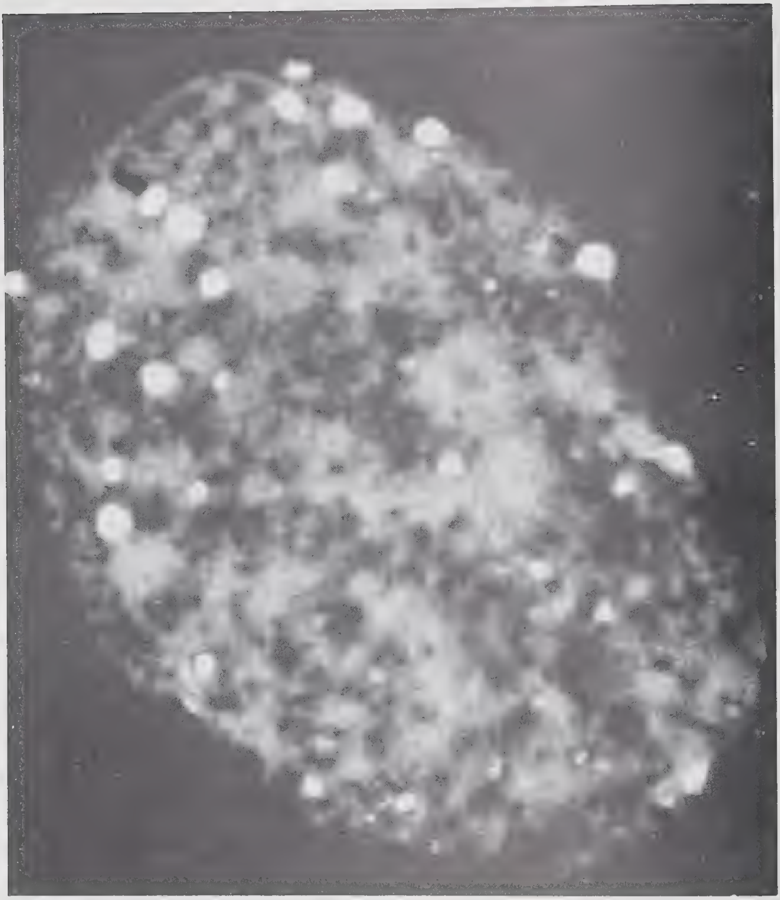

FIG. 2.
Interphase cell showing chromocentres. X1250. Compare Figure 3.

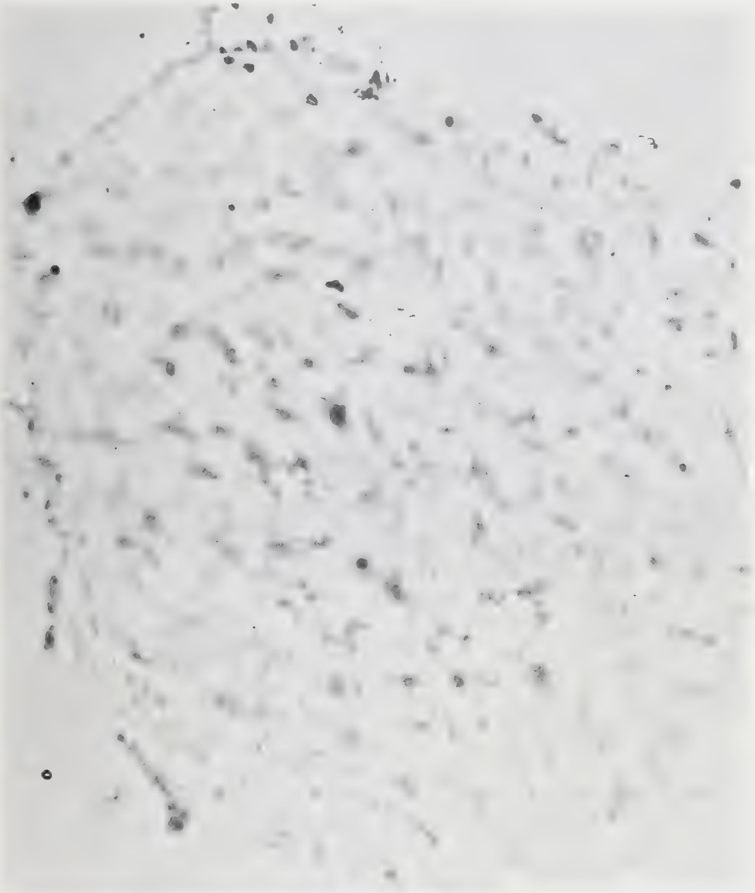

FIG. 3.
The interphase cell shown in Figure 2, photographed with phase contrast using visible light. The fields of view are identical, the nucleus appearing larger in this photograph due to rupture of the nuclear membrane having released non-fluorescent material into the cytoplasm.

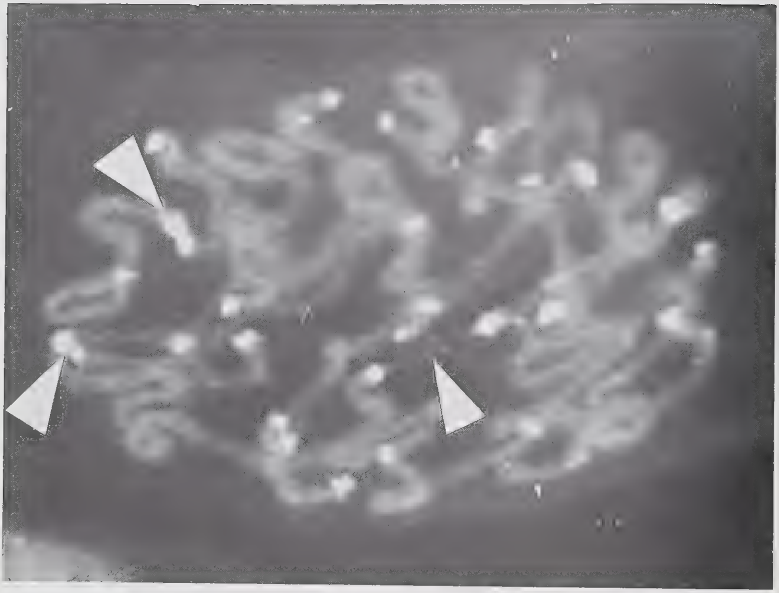

FIG. 4.
Early prophase cell, showing terminal attachments (arrowed). X1250.

Jl S. Afr. Bot. 43 (1): 103 (1977)

BOOK REVIEW

INTERCELLULAR COMMUNICATION IN PLANTS: STUDIES ON PLASMODESMATA, edited by B. E. S. Gunning and A. W. Robards, with pp. xvi+387 and 90 figures. Berlin-Heidelberg-New York: Springer-Verlag, 1976. US $29,60.

Two well known plant cytologists (Gunning—particularly for his work on transfer cells and Robards—for his book on Electron Microscopy and Plant Ultrastructure, McGraw-Hill) have combined forces as editors of a work that, judging from the title, might precede others on intercellular communication. The book is on the *plasmodesma* and represents the contributions of 13 authors. Except for Robards and D. T. Clarkson, both from the UK, the remaining 11 authors are Australian biologists, no less than eight of them from the Australian National University, Canberra City.

One might be excused for initially thinking that with 13 participating authors there should of necessity be an unnecessary duplication of coverage. However, this is not the case and the editors have seen to it that the contributions from the respective physiologists, virologists, biophysicists and cytologists were properly dovetailed to avoid some of the obvious pitfalls which normally attend the amalgamation of conference proceedings.

The treatise is voluminous, but on balance it is a well-reviewed and well-documented account of the current status of knowledge of a cell structure that, probably more than any other, is responsible for the establishment and maintenance of histogenic and, by implication, organogenic continuity. The book discusses the origin, development and occurrence of *plasmodesmata* in lower and higher plants and deals with their function in intercellular water, iron and nutrient transport. In addition, it considers special problems of electrophysiological communication and virus movement.

Robards' term *desmotubule*, used to describe the protoplasmic thread that traverses the plasmodesmatal canal, seems to have gained general acceptance. I did not find reference to Schulz and Jensen's view that this thread might be a microtubule, but it is possible that I overlooked it.

The editors have collected all the references under a special section on bibliography rather than follow the convention of at least some proceedings of including them at the end of each respective contribution. This makes for easier access to all the literature consulted by the authors.

This book on *plasmodesmata* may be regarded by some botanists as rather specialized, but I am sure it will be welcomed and used by all serious cytologists and by physiologists interested in phenomena of transport and communication. A thorough treatment of this topic has been long overdue and one would hope that it might be followed by others, to throw light on other often confusing or perplexing cytological problems, for example, such as those concerning microbody ontogeny and development.

The most important message of this book, as far as I am concerned, is that it has underscored the strength of Australian botany and more particularly that of one department in one Australian university. Also, as far as I am concerned, it has helped once again to underline our wasted potential in South Africa in this regard.

CHRIS H. BORNMAN

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VEGETATION STANDING CROP OF THE GREY LAVA FLOWS AND OF THE EASTERN COASTAL PLAIN ON MARION ISLAND

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ABSTRACT

On sub-Antarctic Marion Island, slope plant communities support higher standing crops than do mire and fjaeldmark communities. Due to their predominance on grey lava flows, however, mire and fjaeldmark contribute 98% of the overall standing crop of vegetation occupying these flows. Standing crop values of grey lava plant communities are substantially lower than those previously reported for the corresponding communities on black lava. Data from black and grey lava vegetation covers are combined according to the proportionate representation of each lava type on the island's eastern coastal plain, yielding an estimate of the overall vegetation standing crop of this larger area. Marion Island vegetation possesses a higher above-ground, but lower below-ground standing crop than most comparable, low-growing northern hemisphere tundra vegetations. This supports previous observations that conditions for plant growth are less severe in sub-Antarctic than in low Arctic and sub-Arctic regions.

UITTREKSEL

DIE VEGETASIE STAANDEOES OP DIE GRYS LAWA GEBIEDE EN DIE OOSTELIKE KUSVLAKTE VAN MARIONEILAND

Op die sub-Antarktiese eiland Marion toon plant gemeenskappe van die hange op grys lawa hoër staandeoeste as moeras en fjaeldmark gemeenskappe alhoewel die twee laasgenoemde 98% van die staandeoes van die grys lawa gebiede as geheel bydra weens hulle oorheersing in die gebiede. Die staandeoeste van die plantgemeenskappe op grys lawa is aansienlik laer as die van ooreenstemmende gemeenskappe op swart lawa. Die vegetasie van die laagliggende ooste gedeelte van die eiland besit 'n hoër bogrondse staandeoes maar 'n laer ondergrondse staandeoes as in soortgelyke vegetasies van die toendra van die noordelike halfrond. Dit bevestig vorige waarnemings dat toestande vir plantegroei in die sub-Antarktiek minder nadelig is as in sub-Arktiese en Arktiese streke.

INTRODUCTION

Marion Island (46°54′S, 37°45′E) is volcanic in origin and is composed of two distinct lava types, a grey preglacial and a black postglacial eruption. Situated in the sub-Antarctic region the island experiences low temperatures (annual mean 5,1°C), high humidities (annual mean 83%) and a high incidence of gale-force winds. The island's biota lacks in species diversity and only 35 vascular plant species (all low-growing graminoids and dwarf shrubs) occur in the vegetation. Due to the inclement weather conditions only the lowland areas (below 500 m) support closed plant communities, the mountainous interior being occupied largely by permanent

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ice and snowfields and bare, rocky peaks vegetated only by lichens and a few mosses. In many respects Marion Island can be considered to possess a tundra-type biome and comprehensive descriptions of this biome are provided in Van Zinderen Bakker, *et al.*, (1971) and Smith (1976).

The coastal plain on the northern, eastern and south-eastern portions of the island forms an area 4–5 km wide, rising gently from sea-level to the foot of the mountainous interior at about 300 m. In this account, the term *eastern coastal plain* is used to describe this whole coastal region, distinguishing it from the western coastal plain which is much narrower (about 1 km) and occupied largely by halophytic plant communities capable of withstanding the large amounts of sea-spray deposited onto the surface by the strong, predominantly westerly, winds.

Black and grey lava types are well represented on the eastern coastal plain, forming approximately 73% and 27% respectively of the area below 500 m (estimated by planimetry from the geological map of Verwoerd and Langenegger, 1971). There is a striking contrast between the formerly glaciated grey lava areas and those which have subsequently been covered by younger black lava flows. The latter generally form a hummocky, well vegetated mosaic of herbfield, mire and fjaeldmark while the smooth topography of the glaciated areas offers little protection from wind erosion and consequently supports a sparser flora, mostly open fjaeldmark on the ridges with mire vegetation occupying the numerous ill-drained basins. Slope areas supporting plant communities similar to those prevalent in black lava areas are uncommon.

The standing crops of plant communities occurring on the black lava flows are provided in Huntley (1972) and Smith (1976). This paper presents corresponding data for plant communities situated on the grey lava areas as well an an assessment of the overall standing crop of the vegetation of the island's eastern coastal plain. Skua Ridge, approximately 1½ km north of the meteorological station, is typical of the grey lava flows of this coastal plain and a 1,3 hectare area, approximately 750 m inland and 80 m above sea level, formed the intensive study site for the investigation.

TERMINOLOGY AND METHODS

1. *Terminology*

Biomass refers to living plant matter while *standing crop* is the sum of alive and dead material. Because of difficulty in distinguishing below-ground living and dead material, these two components are not reported separately but rather the composite figure (below-ground standing crop) is presented.

2. *Methods*

The standing crop estimates presented in Table 2 reflect the average maximum standing crops (oven-dry basis) attained by the plant communities in the study site during the 1971/2 growing season. The harvest method employed is described in detail in Smith (1976).

The relative areas occupied by each plant community on the surface of the study site are not representative of their proportions in the grey lava regions of the island's eastern coastal plain as a whole. In order to provide an estimate of the overall vegetation standing crop of these regions, an assessment of the true extent of each community within the larger area had to be made. Several traverses of the Skua Ridge, Long Ridge and Kerguelen Rise – Stony Ridge areas were marched on fixed compass bearings and the number of footfalls, or footsteps, in each plant community encountered on the marches was recorded. Points were 75 cm apart and this distance was kept constant by a piece of string tied between the walker's feet. This modified step-point method proved to be a rapid means of assessing the relative areas occupied by the different plant communities.

RESULTS AND DISCUSSION

1. *Description of the plant communities*

The topography of Skua Ridge is that of a flat, exposed plateau consisting mainly of fjaeldmark (possessing a thin, discontinuous layer of soil and strewn with slabs of frost-shattered grey basalt; Figure 1) and mire vegetation (occupying depressions in the plateau and overlying wet, usually amorphous, peat deposits;

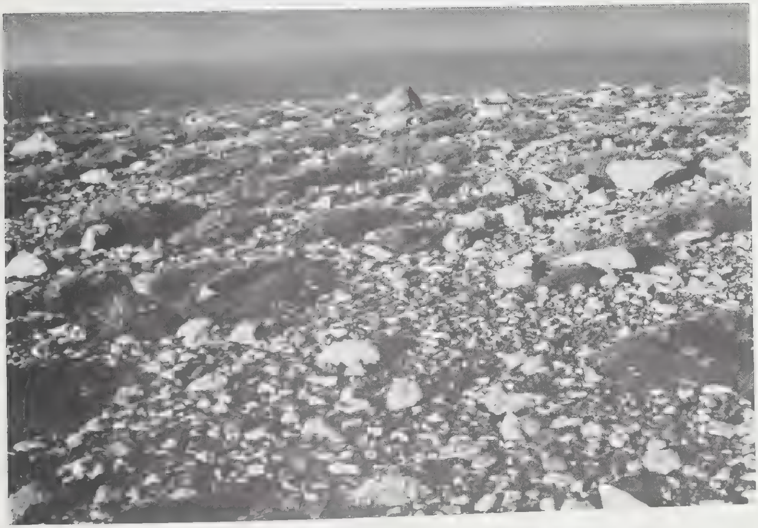

FIG. 1.
Fjaeldmark on grey lava. Cushions of *Azorella selago* support scattered *Agrostis magellanica* plants. Distance to land horizon approximately 20 m.

TABLE 1.

Percentage aerial cover values of component species in plant communities of grey lava flows and the proportionate representation (%) of these communities on these flows.

Plant Community	*B. penna-marina*	*Poa cookii*	*Azorella selago*	*A.* [1]*magellanica*	*A.* [2]*magellanica*	Bryophytes	Algal mats	Other	% area occupied on grey lava
Slope complex									
Closed-fernbrake	95	1	5	tr	nil	nil	nil	tr	0,04
Open-fernbrake	12	1	38	50	0,5	nil	nil	tr	1,10
Tussock grassland	tr	70	15	10	nil	30	nil	tr	0,43
Fjaeldmark									
A. selago fjaeldmark	tr	0	16	tr	4	1–2	nil	tr	39,30
Mire									
A. [2]*magellanica* mire	nil	nil	0,5	nil	40	40–70	0–2	10[3]	59,00

1 *Acaena magellanica*

2 *Agrostis magellanica*

3 Including *Uncinia dikei* (3%), *Juncus scheuchzerioides* (5%) and *Ranunculus biternatus* (2%).

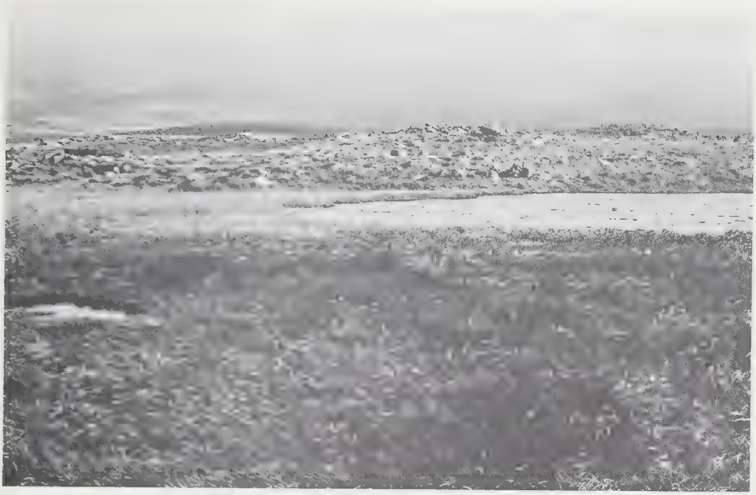

FIG. 2.
View of the southern portion of the grey lava study site with mire in foreground and fjaeldmark in background. Distance to lake approximately 20 m.

Figure 2). Two slopes supporting slope plant communities occur in the study site and are covered by a closed *Blechnum penna-marina* (Poir) Kuhn fernbrake community and, on more exposed aspects, by a stunted open-fernbrake community in which there is a greater importance of *Acaena magellanica* Lam. Vahl and *Azorella selago* Hook. f. A small area on one slope is occupied by burrowing bird species and supports a dense *Poa cookii* Hook. f. – *Acaena magellanica* tussock grassland. A summary of the floristic compositions of the plant communities is presented in Table 1. Also provided in the table is the percentage surface area occupied by each plant community on grey lava flows of the eastern coastal plain as a whole. The predominance of mire and fjaeldmark vegetations on these flows is apparent in the table.

The mire community is similar in species composition to black lava mire areas (Smith, 1976), being dominated by *Agrostis magellanica* Lam. and several bryophyte species (especially *Jamesoniella colorata* (Lehm.) Schiffn. and *Racomitrium lanuginosum* (Hedw. Brid.). The fjaeldmark vegetation consists almost entirely of *Azorella selago* cushions scattered within a loose aggregation of rocks and pebbles (Figure 1).

2. *Standing crops of plant matter in the communities*

The standing crops of the plant communities in the grey lava study site are presented in Table 2. Also included in Table 2 are the contributions (in kg ha^{-1}) of

TABLE 2.

Standing crops (g m^{-2}) of plant communities on grey lava flows and the contributions of these communities to the standing crop (kg ha^{-1}) of the vegetation of these flows.

	Above-Ground Biomass Vasc.	Above-Ground Biomass Crypto.	Above-Ground Biomass Total	Dead O.M.	Total S.C.	Below Ground S.C.	Total Stand. Crop	S.C. in average ha.
Slope Complex								
Closed-fernbrake	310±16	—	310±16	872±85	1 182	3 156±310	4 338	17
Open-fernbrake	439±16	—	439±16	1 260±106	1 699	1 238±83	2 937	323
Tussock grassland	735±29	70±23	805	187±53	2 676	2 687±211	5 363	230
Fjaeldmark								
A. selago fjaeldmark	111±12	—	111±12	645±38	756	418±61	1 174	4 614
Mire Complex								
A. magellanica mire	97±18	147±76	244	242±63	486	1 778±313	2 264	13 358

these communities to the total standing crop of an average hectare of the grey lava flows of the eastern coastal plain, according to their proportionate representation as presented in Table 1.

Plant communities of the slope complex support far higher standing crops of plant matter than do those of mire and fjaeldmark areas. This is in accordance with the data from black lava regions (Smith, 1976) and with observations on other hummocky and hillocky tundra areas (Rodin and Bazilevich, 1967). Surprisingly, the open-fernbrake community exhibits a greater above-ground biomass and standing crop than does closed-fernbrake. Although this difference is significant at P = 0,001, sampling errors in clipping and subsequent sorting of the harvested material are responsible for the high above-ground standing crop component values for open-fernbrake. *Acaena magellanica* accounts for 50% of the aerial cover of this vegetation (Table 1) and the large perennial stems contribute 46% of the above-ground biomass. This latter figure is erroneously high as it is difficult to distinguish the uppermost portions of *Acaena* roots from the stem material (Walton, 1976) and in open-fernbrake communities on grey lava wind erosion exposes some of the roots at the surface so that these were included in the above-ground component during sorting. This also accounts for the low below-ground standing crop estimate for this community. Large amounts of litter accumulate in *Azorella selago* cushions and this also adds substantially to the above-ground standing crop in open-fernbrake. Both open- and closed-fernbrake on grey lava possess lower standing crops (66% and 71% respectively) than do the corresponding black lava communities (Smith, 1976).

Tussock grassland exhibits the highest above-ground and total standing crops of all grey lava plant communities. This is due to the large amounts of living and dead plant material which accumulate in the *Poa cookii* swards and to the large perennial stems of *Acaena magellanica* and supports previous observations on sub-Antarctic tussock grasslands (Macquarie Island: Jenkin and Ashton, 1970; South Georgia: Walton, Greene and Callaghan, 1975). The above-ground standing crop (2 676 g m^{-2}) for grey lava tussock grassland agrees closely with that previously measured on a similar tussock grassland on black lava (2 617 g m^{-2}, Smith, 1976).

Mire vegetation possesses very low amounts of living and dead above-ground vascular plant material and consequently exhibits the lowest above-ground standing crop of all plant communities on grey lava. Sixty percent of the aerial biomass in mire areas is attributable to bryophytes. The above-ground biomasses of grey and black lava mires are approximately similar (97 ± 18 g m^{-2} and 117 ± 29 g m^{-2} respectively). Algal mats do not contribute significantly to the standing crops of mire communities on either lava type (Croome, 1973; Smith, 1976).

Fjaeldmark supports the lowest above-ground biomass and total standing crop of all grey lava plant communities. Due to the large amount of dead material which accumulates in *Azorella* cushions, however, the above-ground standing crop of fjaeldmark vegetation is substantially greater than that of the mires.

3. *Standing crops of grey lava vegetation and of the island's eastern coastal plain as a whole*

Mire and fjaeldmark communities account for 72% and 25% respectively of the total vegetation standing crop on grey lava flows (Table 2). Thus, despite their high standing crops, slope communities do not contribute significantly to the total standing crop of the vegetation on these flows. The standing crop of grey lava vegetation, based on the proportionate representation of the various grey lava plant communities, is presented in Table 3. The contribution of closed-fernbrake (<0,1%) is ignored in the table. Also provided in Table 3 are the standing crop of black lava vegetation (Smith, 1976) and a combined standing crop value for the vegetation of the island's eastern coastal plain as a whole, based on the proportionate representation of the two lava types in this area.

TABLE 3.
Standing crops (kg ha^{-1}) of vegetation on the island's eastern coastal plain.

	Standing Crop Component (kg ha^{-1}).						
	Above-ground					Below-Ground	Total Stand.
	Biomass			Dead	Total		
	Vasc.	Cryp.	Total	O.M.	Above	Total	Crop
Black lava	3 060	840	3 900	11 050	14 950	22 620	37 570
Grey lava	1 088	870	1 959	4 182	6 140	12 389	18 525
Eastern coastal plain	2 528	848	3 376	9 196	12 571	19 858	32 428

The standing crop components of black lava vegetation are 2 to 2½ times greater than those of grey lava vegetation. This is due to the higher altitude ~~and~~ greater exposure of the grey lava sites and to the importance of mire and fjaeldmark rather than of closed, slope plant communities in these sites.

The above-ground biomass (2 528 kg ha^{-1}) of vascular plants on the Marion Island eastern coastal plain is similar to those (2 180 to 2 500 kg ha^{-1}) of mosaic and hillocky tundra areas consisting of sedges, mosses, lichens and dwarf shrubs of the U.S.S.R. low Arctic and sub-Arctic (Rodin and Bazilevich, 1967) and of sub-Arctic grassland and sedge-swamp communities (2 340 to 2 420 kg ha^{-1}) in Swedish Lapland (Pearsall and Newbould, 1957). A low (848 kg ha^{-1}) cryptogam biomass occurs in the island vegetation, however, in contrast to the dominance of cryptogams at these sub-Arctic and low Arctic areas. The large amount of dead vascular plant material which accumulates in the island vegetation causes the above-ground standing crop (12 571 kg ha^{-1}) to be substantially higher than those of these northern circumpolar tundra vegetations (8 700 to 10 000 kg ha^{-1}).

Data in Bliss (1962) and Scott and Billings (1964) indicate that alpine shrub and meadow communities support much lower above-ground biomasses and standing crops than occur in the island vegetation.

In contrast to the high above-ground standing crop, the island vegetation possesses a lower quantity (19 858 kg ha^{-1}) of below-ground plant matter than do comparable sub-Arctic and low Arctic tundra vegetations (23 070 to 62 260 kg ha^{-1}; Rodin and Bazilevich, 1967), agreeing with similar observations on Signy Island (Edwards, 1973) and South Georgia (Walton, *et al.*, 1975). This supports proposals by Bliss (1970) and Dennis and Johnson (1970) that environmental limitations to standing crop are relatively more severe for the above-ground than the below-ground parts of plants and that although annual below-ground production is lower in the Arctic than in more temperate regions, the roots live longer and decompose more slowly. This longer root life, coupled with a slower decomposition rate, means that the below-ground vegetation standing crops in the cold, often frozen soils of northern circumpolar regions are often higher than in the warmer (and wetter) soils of Marion Island (Smith, 1976).

The high above-ground standing crop of the island vegetation agrees with the view expressed by Walton, *et al.*, (1975) that conditions in the sub-Antarctic region may be considerably less severe than those experienced at other tundra sites and supports Wielgolaski's statement (Wielgolaski, 1972) that in the sub-Antarctic region (Macquarie Island and South Georgia) the growth relationships can be characterised, ecologically, as good.

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A REVISION OF GRUBBIACEAE

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ABSTRACT

The family Grubbiaceae, endemic to Cape Province, is regarded as consisting of a single genus, *Grubbia*, with three species: *G. rosmarinifolia*, *G. rourkei*, and *G. tomentosa*. *Grubbia tomentosa* is a uniform species, widespread on the Table Mountain Sandstone, and is the closest relative of the new species, *G. rourkei*, endemic to Kogelberg. *Grubbia rosmarinifolia* tends to be polymorphic, but from the "typical" populations, *G. rosmarinifolia* subsp. *hirsuta* (mountain ranges from Bainskloof to the Cedarberg) and *G. rosmarinifolia* subsp. *gracilis* (Muizenberg Plateau) can be segregated as morphologically and geographically distinct subspecies. The plants formerly recognized as *G. pinifolia* are considered as variety of *G. rosmarinifolia* subsp. *rosmarinifolia*.

UITTREKSEL

'n HERSIENING VAN GRUBBIACEAE

Die familie Grubbiaceae, endemies in die Kaapprovinsie, word beskou as bestaande uit 'n genus, *Grubbia*, met drie spesies, nl. *G. rosmarinifolia*, *G. rourkei*, en *G. tomentosa*. *Grubbia tomentosa* is 'n uniforme spesies wydversprei op die Kaapse sandsteen en is die naaste verwant aan die nuwe spesies, *G. rourkei*, endemies in die Kogelberg. *Grubbia rosmarinifolia* is geneig tot polimorfisme, en *G. rosmarinifolia* subsp. *hirsuta* (bergreekse vanaf Bainskloof tot die Sederberge) en *G. rosmarinifolia* subsp. *gracilis* (Muizenberg-Plato) kan van die ,,tipiese" populasies as duidelike morfologiese en geografiese subspesies afgeskei word. Die plante, voorheen as *G. pinifolia* erken, word as 'n variëteit van *G. rosmarinifolia* subsp. *rosmarinifolia* beskou.

INTRODUCTION

In order to present my findings on wood anatomy of Grubbiaceae, a revision of *Grubbia*, the sole genus of Grubbiaceae, was required. Several taxonomic changes, including description of a new species, were needed in order to make available names for the wood studies. Such a revision had been begun some years ago, as annotations of specimens indicate, by Miss M. A. Gutzwiller, who unfortunately could not complete this task. During my field studies in Cape Province in 1973, I collected materials of the three species of *Grubbia* recognized here. However, study of additional specimens from South African herbaria was required. *Grubbia rosmarinifolia* (Figs. 1–5, 18–21) proves to be a polymorphic species from which the species *G. gracilis*, *G.hirsuta*, and *G. pinifolia* have been segregated. As the species names suggest, *G. rosmarinifolia* is a complex in which various populations differ chiefly in foliar characteristics. *Grubbia tomentosa* and a new species described here, *G. rourkei*, are relatively uniform throughout their ranges.

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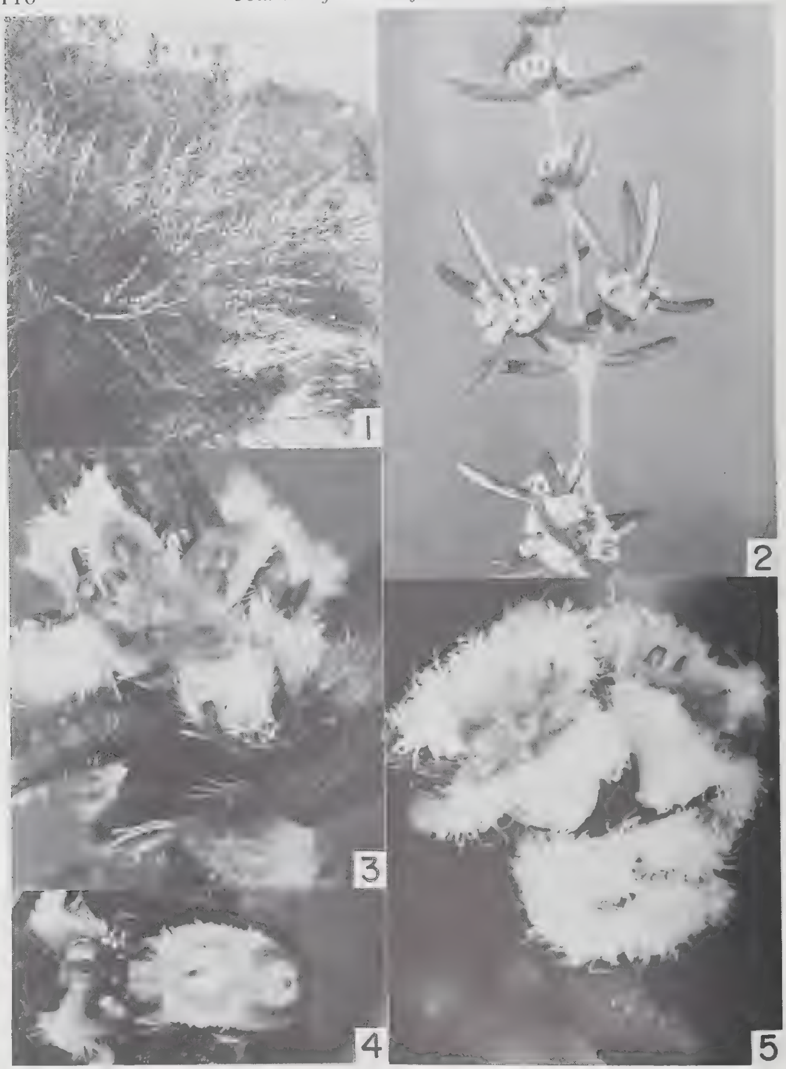

FIG. 1–5.

Grubbia rosmarinifolia subsp. *rosmarinifolia* var. *rosmarinifolia*, *S. Carlquist 4719*. *1*. Habit of an old shrub, *ca.* 1 m high, showing spreading habit. 2. Branchlet in flower. X 2. 3. View of flower, showing anthers unopened. X 15. 4. Inflorescence in which two flowers at right have lost perianth; outer surface of ovary is pilose, ovary tops are papillate. X 15. 5. Flowers showing characteristics of hairs on perianth and scabrid nature of leaf, below. X 15

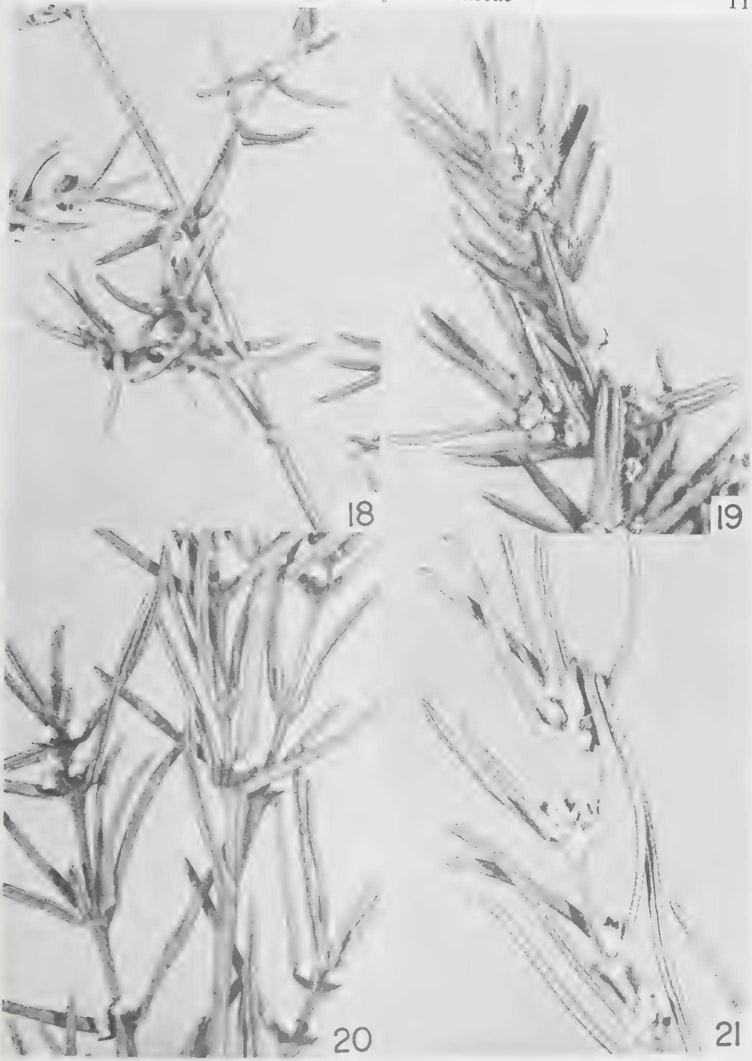

FIG. 18–21.

Photographs of branchlets of *Grubbia rosmarinifolia* herbarium specimens, to show details of leaves and vesture. 18. *G. rosmarinifolia* subsp. *gracilis*, *G.J. Lewis 1321* (SAM). 19. *G. rosmarinifolia* subsp. *hirsuta*, *R.H. Compton 20986* (NBG). 20. *G. rosmarinifolia* subsp. *rosmarinifolia* var. *pinifolia*, *T.P. Stokoe 60060* (SAM). 21. *G. rosmarinifolia* subsp. *rosmarinifolia* var. *rosmarinifolia*, *T.P. Stokoe 63133* (SAM). All, X 2.

The three species of Grubbiaceae can be regarded as relictual mesic elements, as their habitat preferences indicate, within the mediterranean-type flora of Cape Province. However, each of the three species exploits a different mesic habitat. An understanding of these features is essential to any attempt to relate Grubbiaceae to other families. The systematic position of the family, a controversial problem (e.g., Fagerlind, 1947), is discussed in a following paper (Carlquist, 1977).

SYSTEMATIC TREATMENT

Grubbiaceae Endl., Gen. Pl. 327, 1837. *Grubbia* Berg., Kongl. Vet. Acad. Handl. **28:** 34, 1767. Much-branched woody shrub, branched from a single stem and with a taproot, or branched from a lignotuber at the surface of the ground. Leaves decussate, ericoid, or flat, with margins at least somewhat revolute, linear to lanceolate or obcuneate, acuminate, petiolate to nearly sessile. Inflorescences axillary, basically dichasial but congested, subtended by two or more bracts, with two to about 20 flowers. Flowers bisexual, very small. Perianth in a single whorl, tetramerous, calyx-like and hairy on the outer surface, smooth and suffused pink to red on the inner surface, valvate. Stamens eight, free, with a slight tendency for four to be positioned inward of the remaining alternating four. Filaments linear-lanceolate; anthers basifixed, with two adaxial functional anther sacs and a pair of abaxial vestigial sacs each. Anther sacs dehiscent by means of lateral slits. Disc epigynous, papillate to shortly hairy. Ovary inferior, bicarpellate, sometimes bilocular at an early stage and unilocular later. Style filiform, stigma apical, small, with a very short pair of branches or apparently simple. One ovule in each locule, pendent, anatropous, unitegmic, tenuinucellar, with a long micropyle. Fruit indehiscent, with a fleshy exocarp and a sclerenchymatous endocarp, each fruit united with adjacent fruits in an inflorescence, forming a syncarp. Seed with abundant oily endosperm, the endosperm heavily cutinized at its outer surface. Embryo straight, hypocotyl and radicle longer than the two cotyledons. Type species: *G. rosmarinifolia* Berg. Generic synonyms: see below under Sections.

KEY TO THE GENUS *GRUBBIA*

Flowers in a cymose group of 2 or (mostly 3), sessile in axils of leaves; inflorescences subtended by a pair of dark brown scarious broad bracts; fruits small (*ca.* 1 mm in diameter), forming a syncarp, probably wind-dispersed ....A. **G. rosmarinifolia** (sole species of section I, *Ophira*)

Leaves lanceolate to linear, 0,5 to 2,2 cm long, 1–2,5 mm wide (juvenile leaves occasionally wider), hirsute to glabrous above, tomentose below. Bracts of the inflorescence ⅓ to ½ bilobed. Table Mt., Hottentots Holland Mts., Klein Rivier Mts., Cape Infanta, Langeberg east to mountains in Knysna and Uniondale Divisions ....A–1a **G. rosmarinifolia** subsp. **rosmarinifolia**

Leaves sagittate at bases, 0,8–1,2 cm long, petioles about 1 mm long. Widespread in Cape Province ....A–1a$_1$ **G. rosmarinifolia** subsp. **rosmarinifolia** var. **rosmarinifolia**

Leaves not sagittate at bases, lamina bases in brief rounded lobes or fading into the petioles; lamina glabrous above, linear, 1,2–2,2 cm long, petioles 1–2 mm long. Local in deep valleys on Table Mt. and in the Hottentots Holland Mts. .. ..A–1a$_2$ **G. rosmarinifolia** subsp. **rosmarinifolia** var. **pinifolia**

Leaves narrowly obcuneate, 3,5–6 mm long, scabrid to glabrescent above, tomentose below. Bracts of the inflorescence ¼ bilobed. Subshrub endemic to the Muizenberg Plateau ....A–1b **G. rosmarinifolia** subsp. **gracilis**

Leaves lanceolate (the uppermost linear), 0,8–2,7 cm long, densely long-hairy or strigose above, strigose-tomentose below. Bracts of the inflorescence ovate, entire. Cape Province from Bainskloof to the Cedarberg and Kwadousberg ....A–1c **G. rosmarinifolia** subsp. **hirsuta**

Inflorescences strobiloid, subsessile in leaf axils, with three smaller and one larger deltoid green lanceolate bracts. Flowers 6–20 (occasionally 4) per inflorescence. Fruit a round or ovoid syncarp, 5 mm or more in length, usually with one large seed per syncarp maturing; syncarp probably bird-dispersed .... Section II, *Strobilocarpus*.

Shrub branched from a massive lignotuberous base. Leaves minutely tomentose, 2,4–6,5 cm long, 7 mm broad, margins inconspicuously revolute. Petioles 3–6 mm long. Nodes of stems and sulci between fruits of the syncarp minutely tomentose. Fruits of the syncarp green, turning purple at maturity. Widespread in Cape Province on Table Mountain Sandstone ....B. **G. tomentosa**.

Shrub with a single trunk, no lignotuber present. Leaves subscabrid, about 1,5 (1,0–2,0) cm long, 1,4 mm wide, margins strongly revolute. Petioles shorter than 3 mm. Nodes of stems and sulci between fruits of the syncarp hispid. Fruits of the syncarp each reddish with a central yellow spot at style base at maturity. Endemic to Kogelberg, Cape Province ....**G. rourkei.**

DESCRIPTIONS

I. SECTION **OPHIRA** (J. Burmann) A. DC., Prodr. **14:** 618, 1857. *Ophira* J. Burmann (as a genus) ex Linn., Mantissa **2:** 150, 1771. *Ophira* Steud., Nom., ed. 2, **2:** 220, 1841. *Ophiria (sic)* of some authors. Stems round or nearly so in transection. Leaves lanceolate or linear, margins strongly revolute in adult leaves, somewhat less so in juvenile leaves. Flowers in groups of 2 or (mostly) 3, sessile in the axils of leaves; inflorescences subtended by a pair of dark brown scarious broad obtuse bracts. Fruit small, a syncarp composed of the two or three cymosely arranged fused ovaries, apparently wind-dispersed.

A. **Grubbia rosmarinifolia** Berg., Kongl. Vet. Acad. Handl. **28:** 34, 1767. (Synonym: *Ophira stricta* Linn., Mantissa **2:** 229, 1771, *non* Lam.) Characters of the section *Ophira*, of which it is the sole species.

A–1a. **Grubbia rosmarinifolia** subsp. **rosmarinifolia**. Shrub to 1,5 m, branches erect (spreading with age), branchlets pubescent to short-hirsute. Leaves shortly petiolate, petioles 1–2,5 mm long; leaves 0,5–2,2 cm long, 1–2,5 mm wide (juvenile leaves occasionally wider), strongly revolute, variously scabrid to glabrous above, tomentose below. Bracts of the inflorescence $^{1}/_{3}$ to $^{1}/_{2}$ bilobed. Flowering season: August to December.

A–1a$_1$. **Grubbia rosmarinifolia** subsp. **rosmarinifolia** var. **rosmarinifolia** (Fig. 1–5, 21). (= *G. rosmarinifolia* of most authors). Leaves slightly or markedly sagittate at base, bases rounded; lamina scabrous, hirsute to glabrous above, pubescent beneath, 0,5–1,8 cm long, most frequently 0,8–1,2 cm long. Petiole about 1 mm long. Range: Cape Province, from near Gydo Pass, Ceres Division, southward to the Hottentots Holland Mts. and various parts of Caledon Division, Klein Rivier Mts., Kogelberg; Bredasdorp Division; Riviersonderend Mts. and the

Langeberg from near Swellendam to Garcias Pass; Outeniqua Mts. from Montagu Pass to the Tsitsikama Forest. Streamsides and seeps, mostly on south-facing slopes, from near sea-level (Palmiet River) to about 2 000 m. For a discussion of the type specimen, see Harms (1935).

REPRESENTATIVE SPECIMENS

Cape Peninsula: Table Mt.: *Drège 20097* (SAM), *H. Bolus 3943* (NBG), *R.H. Compton 6691* (SAM); Table Mt. above Echo Valley, *R.H. Compton 8288* (NBG); Table Mt., top of Kasteelspoort, *E. Cohen* 20–VIII–1938 (NBG).

Ceres Division: Visgat, between Schurfteberg and Gt. Winterhoek Mts., *T.P. Stokoe 63133* (SAM).

Caledon Division: Nieuwberg, *P. Bond 485* (NBG), *R.H. Compton 9211* (NBG); Viljoens Pass, *T.P. Stokoe 57839* (SAM); between Somerset Sneeukop and Dwarsberg, Hottentots Holland Mts., *T.P. Stokoe 60061* (SAM); Kogelberg, *T.P. Stokoe 57836* (SAM), *R.H. Compton 16862* (NBG); Palmiet River, *T.P. Stokoe 57838* (SAM), *R.H. Compton 1[illegible]10* (NBG), *S. Carlquist 4591* (RSA, NBG); Klein Rivier Mts., upper Fernkloof, *I. Williams 1533* (NBG), *S. Carlquist 4508* (A, BOL, CAS, MO, NBG, RSA, US), *S. Carlquist 4962* (BOL, CAS, MO, NBG, RSA, US); Silverstream, near Villiersdorp, *P. Goldblatt 1816* (NBG); Rivier Zonder Einde (mts. above Riviersonderend), *Pappe 20099* (SAM).

Bredasdorp Division: Hagel Kraal, *J.P. Rourke 615* (NBG); Pottberg Estates, near Cape Infanta, *R.D.A. Bayliss 6622* (NBG).

Swellendam Division: Clock Peaks, *R.H. Compton 858* (NBG); One O'Clock Mt., *T.M. Wurts 290* (NBG); 11:30 O'Clock Peak, *S. Carlquist 4719* (BOL, NBG, RSA); Strawberry Hill, near Heidelberg, *T.P. Stokoe 70001* (SAM).

Riversdale Division: Garcias Pass, *C. Thorne 38854* (SAM); Langeberg near Riversdale, *R. Schlechter 1833* (NBG).

George Division: Montagu Pass, *R.H. Compton 8476* (NBG), *J.P. Rourke 1257* (NBG); Cradock Berg, *R.H. Compton 14381* (NBG).

Knysna Division: Lottering, *H.C. Taylor 574* (NBG); Tzitsikama (Tsitsikama), *Pappe 20098* (SAM).

Uniondale Division: Formosa, *R.H. Compton 4258* (NBG).

A–la$_2$. **G. rosmarinifolia** subsp. **rosmarinifolia** var. **pinifolia** (Sond.) S. Carlquist, comb. nov. (*G. pinifolia* Sond., in Harvey and Sonder, Fl. Cap. **2:** 326, 1894). Leaves not sagittate at base, lamina glabrous above, densely puberulent below, linear, 1,2–2,2 cm long. Petiole 1–2 mm long. Range: Cape Province, Hottentots Holland Mts. and vicinity; Kogelberg; Table Mt. Along streams, in streams in ravines, at about 1 000 m or higher, chiefly on south-facing slopes.

REPRESENTATIVE SPECIMENS.

Cape Peninsula: Table Mt., *MacOwan 918* (BOL, SAM).

Caledon Division: Aries Kraal, *R.H. Compton 16827* (NBG); Nieuwberg, near top of Viljoens Pass, *T.P. Stokoe 69525* (SAM); S.E. side of Somerset Sneeukop, *E. Esterhuysen 3643* (BOL, NBG); between Somerset Sneeukop and Dwarsberg, *T.P. Stokoe 60060* (SAM); Landrostkop, *T.P. Stokoe 57840* (SAM); Grietjesgat, between Sir Lowry's Pass and Palmiet River, *Ecklon and Zeyher* VII–1833 (SAM); Kogelberg, *H.B. Rycroft 1368* (NBG); Palmiet River, *M.C. Gillett 4253* (BOL). For information regarding the type, see Harvey and Sonder (1894).

I am reluctantly recognizing this taxon as a variety, because it has a geographical unity but is within the range of *G. rosmarinifolia* subsp. *rosmarinifolia* var. *rosmarinifolia*, although it may inhabit deeper valleys rather than open streams. If one viewed specimens only from the Hottentots Holland Mts., such as the one shown in Fig. 20, it could be regarded as a subspecies of *G. rosmarinifolia*. However, exceptions do occur in all of the features. The specimen *Stokoe 63133* (Fig. 21) could be included in var. *pinifolia* if leaf length and shortness of petioles were criteria, but in all other features it fits var. *rosmarinifolia*. The Table Mountain population of var. *pinifolia* is slightly different from the Hottentots Holland—Kogelberg plants. Variation in petiole length of var. *pinifolia*, contrary to description, overlaps that of var. *rosmarinifolia*, and leaf base morphology of the varieties tends to intergrade. Thus, no single character is without exception, and indeed, the annotations of specimens of var. *pinifolia* by Miss M. A. Gutzwiller merely bear the determination "*Grubbia rosmarinifolia* subsp. *rosmarinifolia*." Recognition as a variety seems advisable to highlight one distinctive phase, despite intergradation and variability, of *Grubbia rosmarinifolia* subsp. *rosmarinifolia*.

A–lb. **Grubbia rosmarinifolia** subsp. **gracilis** (Salter) S. Carlquist, comb. nov. (*G. gracilis* Salter, Jl S. Afr. Bot. **12:** 39, 1946). Shrub, often sparsely branched, 20–50 cm high, branches spreading, branchlets pubescent. Leaves narrowly obcuneate, margins strongly revolute, sagittate at bases, the lobes obtuse; leaves 3,5–6 mm long, 0,5–2 mm wide, scabrid to glabrescent above, tomentose below. Bracts of the inflorescence keeled, ¼ bilobed. Range: Cape Peninsula, seeps and streams on the Muizenberg Plateau.

REPRESENTATIVE SPECIMENS

Cape Peninsula: Muizenberg Plateau, *Salter 3594* (holotype, BOL; isotypes, BOL, SAM), *R. Schlechter* 7–VIII–1892 (BOL), *R.H. Compton 16430* (BOL, NBG), *E. Esterhuysen 24668* (BOL), *Salter 2948* (BOL), *G.J. Lewis 1321* (SAM). The habit and leaves (Fig. 18) of this subspecies are distinctive, as are quantitative features of wood anatomy (Carlquist, 1977). The distinctive geographical range, outside the limits of *G. rosmarinifolia* subsp. *rosmarinifolia*, is a further reinforcement to subspecific status for subsp. *gracilis*. There are no unique morphological features of subsp. *gracilis* that would merit specific status for this population.

A–lc. **G. rosmarinifolia** subsp. **hirsuta** (E. Mey. ex A. DC.) S. Carlquist, comb. nov. (*G. hirsuta* E. Mey. ex A. DC., Prodr. **14:** 618, 1857). Shrub to 1,5 m, the branches erect. Leaves and branchlets densely long-hairy and strigose. Leaves 0,8–2,7 cm long, lanceolate (the uppermost leaves of adult shoots linear) with sagittate bases, lobes of the bases obtuse. Leaf margins revolute. Petioles about 1 mm long. Bracts of the inflorescence ovate, entire. Range: Cape Province, in montane seeps, or on damp ledges in the north-south ranges of the Cold Bokkeveld, Ceres Division, from Bainskloof to the Cedarberg and Kwadousberg.

REPRESENTATIVE SPECIMENS

Clanwilliam Division: Krom River Kloof, S. Cedarberg, *E. Esterhuysen 17968* (BOL, NBG).

Worcester Division: Kavadouws (Kwadousberg) Mts. near Orchard, *E. Esterhuysen 10908* (BOL, NBG, SAM); Bainskloof, *R.H. Compton 20986* (NBG).

Ceres Division: Tweefontein, Cold Bokkeveld, *R. Schlechter 10125* (BOL, SAM); slopes at E. base of Schurweberg (Schurfteberg), *E. Esterhuysen 12665* (BOL).

The almost hispid vesture, relatively long leaves, and entire inflorescence bracts of this taxon (Fig. 19) distinguish it from *Grubbia rosmarinifolia* subsp. *rosmarinifolia.* With the exception of the specimen *Stokoe 63133*, referred above to subsp. *rosmarinifolia* var. *rosmarinifolia*, the populations of *G. rosmarinifolia* subsp. *hirsuta* are outside the range of other subspecies of *G. rosmarinifolia*. As with *G. rosmarinifolia* subsp. *gracilis*, subsp. *hirsuta* possesses no unique features. Compared with the remainder of *G. rosmarinifolia*, vesture is appreciably more prominent in subsp. *hirsuta*, but of the same basic type as in *G. rosmarinifolia* as a whole.

II. SECTION **STROBILOCARPUS** (Klotsch) A. DC., Prodr. **14:** 618, 1857. (Synonyms: *Strobilocarpus* Klotsch, as a genus, Linnaea **13:** 380, 1839; *Strobilocarpos* Benth and Hook. f., Gen. Pl. 231, 1880; *Ophira* Lam., Encycl. Bot. **4:** 565, 1793 et Ill. in T., *non* Linn.). Shrubs with branchlets having longer internodes than in section *Ophira*. Stems prominently four-angled (in branches and branchlets) as seen in transection, the angles related to decurrent leaf margins or petiole edges. Leaves lanceolate or linear, petiolate, margins slightly to markedly revolute, 2–6,5 cm long. Inflorescences strobiloid, subsessile in leaf axils, with three smaller and one larger deltoid lanceolate bracts arranged decussately below the flowers. Flowers with soft curved canescent hairs on the outer surfaces of the perianth. Flowers 6–20 (occasionally 4), decussately arranged, sessile on the spike. Fruit a syncarp, 5 mm or more in length, with usually one seed maturing per syncarp. Syncarps probably dispersed by frugivorous birds.

B. **Grubbia tomentosa** (Thunb.) Harms, in Engl. Pflanzenfam., ed. 2, **16b:** 51, 1935[1]. (Synonyms: *Taxus tomentosa* Thunb., Prodr. 117, 1800; *Ophira stricta* Lam., Encycl. Bot. **4:**565, et Ill, in T., 1793; *Grubbia stricta* (Lam.) A. DC.,

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[1] For a discussion of nomenclatural resolution in this species, see Harms (1935).

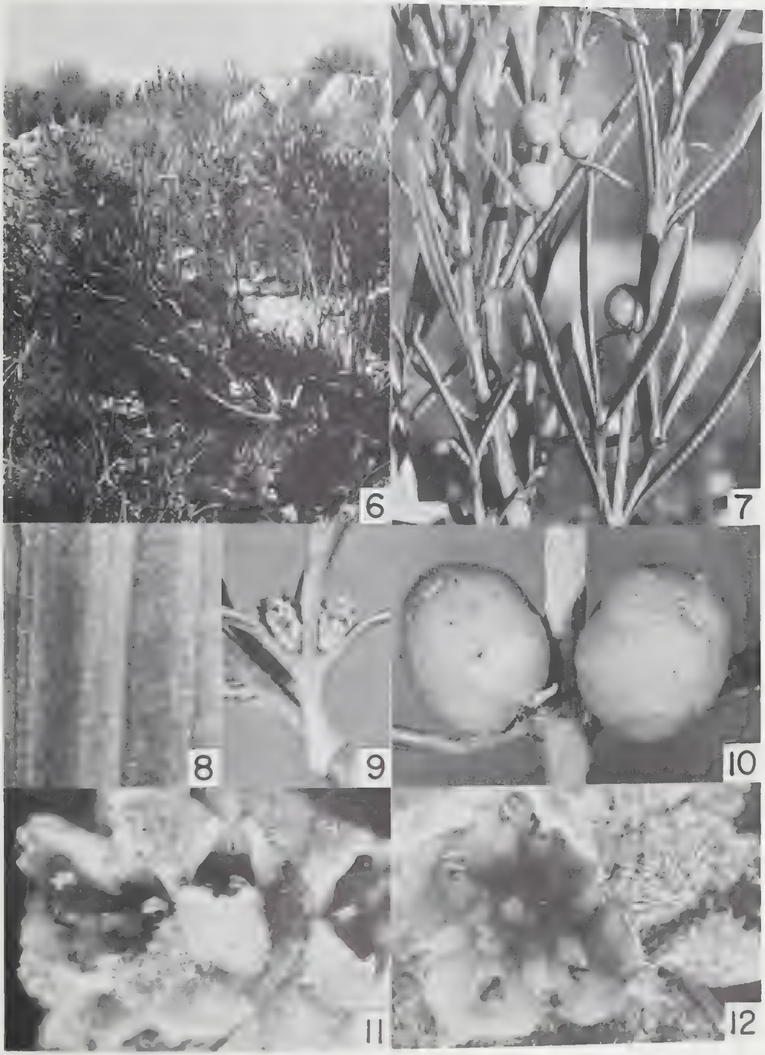

FIG. 6–12.

Grubbia tomentosa, *S. Carlquist 5058*. 6. Habit of shrub *ca.* 0.8 m high; lignotuber at lower right. 7. Habit of branchlets in fruit. X 0,7. 8. Lower surface of leaf. X 4. 9. Pair of inflorescences in leaf axils. X 6. 10. Pair of fruits, prior to turning purple. X 3. 11. Oblique view of flower at anthesis. X 20. 12. Face view of flower at anthesis. X 20.

Prod. **14:**618, 1857; *Strobilocarpus diversifolius,*, Linnaea **13:**380, 1839; *Grubbia latifolia* Schnizlein, Icon. **2:**108, 1856–1865).

Shrub to 1,5 m high, branched from a massive lignotuberous base (Fig. 6) Leaves lanceolate-elliptic (Fig. 7), acuminate, tapering below to a petiole; lamina 2,5–6,5 cm long, 2–7 mm broad. Petiole 3–6 mm long. Leaves glabrous and smooth to minutely tuberculate above, tomentose below (Fig. 8), margins inconspicuously revolute. Stems and nodes finely tomentose. Flowers 15–20, in sessile cone-like groups 5–6 mm long (Fig. 9). Perianth segments ovate, acute (Fig. 11, 12), pale rose within. Bracts of the inflorescence green, deltoid, 1–2 mm long (Fig. 9, 10). Fruit an ovoid syncarp 6–10 mm long, green turning evenly red-purple at maturity, glabrous, margins of each fruit in the syncarp outlined by barely perceptible grooves, not hairy. Exocarp of fruit fleshy, endocarp very thick and woody. Flowering season: December through January according to my observations; I failed to find any individuals in flower from July through November, despite the statement by Salter (in Adamson and Salter, 1950) that *G. tomentosa* flowers throughout the year. Range: Cape Province, chiefly on south-facing slopes below or among large boulders of Table Mountain Sandstone, tending to be at lower elevations from near sea-level (Cape Peninsula) to about 600 m. Hills and mountains from Elandskloof (Ceres Division) southward to the Cape Peninsula and to Sir Lowry's Pass; southern coastal ranges, including the Riviersonderend range behind Genadendal, the Klein Rivier Mts., and the Langeberg from Swellendam to Garcias Pass and to Cradock Berg, George Division, according to Harvey and Sonder (1894). For a discussion of typification of this species, see Harms (1935).

REPRESENTATIVE SPECIMENS

Caledon Division: Klein Rivier Mts., upper Fernkloof, *S. Carlquist 4515* (BOL, CAS, K, MO, NBG, PERTH, US); upper slopes of Vogelgat Reserve (near Hermanus), *S. Carlquist 5010* (BOL, MO, NBG, RSA).

Bredasdorp Division: Slopes above Bredasdorp, *S. Carlquist 5010* (A, BOL, CAS, MO, NBG, PERTH, US).

Swellendam Division: Lower slopes of 11:30 Peak, Langeberg, *S. Carlquist 4559* (BOL, CAS, MO, NBG, RSA).

C. **Grubbia rourkei,** sp. nov. (Synonym: *G. linearifolia* M.-A. Gutzwiller ined., in herb.). Frutex ad 2 m altus, rami laxi. Caulis ramosus supra, simplex et nontuberosus infra. Ramuli nodosi, piloso-glabrescenti, flavidi. Nodi insigne pilosi. Folia ca. 15 (10–20) mm longa, 1,5 mm lata, petiolata, ericoidea, linearia, sordido-cineraria, integerrima, dense et breve pilosa (subscabrida supra), ad apice submucronata, margine revoluta, carinae dense pilosae, flavescentes. Petiolae ad basi connatae. Ramuli floride ad capitulum parvum globosum 5 mm longum strobiliformum in axillis foliorum subsessile reducti et post anthesin fructi in syncarpium globosum connati. Flores 4–10. Internodi ramulorum saepe breves (fertiles) vel longiores, syncarpii subvertivillati. Perianthium roseum, pilis perianthiorum brevis, sordidis. Segmenti perianthiorum arcuati. Fructi syncarpiorum rosei sed ad apice flavo-maculati, pubescenti. Sulci syncarpiorum pilosi. Semen globosum; embryo in centro albuminis linearis, subteres, viridis.

Erect shrub to 2 m tall (Fig. 13), branches spreading. Trunk branched above, but simple below, non-tuberous (unlike *G. tomentosa,* which has at ground level a lignotuber from which branches depart). Branches nodose, pilose when young and glabrescent with age (Fig. 14–16), yellowish to yellowish-green. Nodes conspicuously pilose; petioles of leaf pairs connate at nodes. Leaves about 15 (10–20) mm long, 1,4 mm wide, shortly petiolate, linear, narrow, ashy or pallid drying yellowish-green, entire, glabrous or subscabrid, submucronate at the apex, margin conspicuously revolute, the grooves on the lower surface densely pilose and becoming yellowish (Fig. 14). Flower-bearing shoots reduced to small strobiloid capitula 5 mm in diameter, subsessile in axils of leaves, flowers after anthesis connate into syncarps. Flowers 4–10 per syncarp. Internodes short where axils bear flowers and fruits, which therefore appear to be in subverticillate groups; internodes longer between leaf pairs on shoots where flowers are absent. Perianth rosy within, hairs on outer surface of perianth short, brownish-white. Perianth lobes (as observed in living specimens) arcuate, tips tending to touch at anthesis and the flower therefore tending to open with slits between the lobes (Fig. 17). Fruits of the syncarp pubescent, each fruit red with a central yellowish-green spot (Fig. 14). Sulci between fruits of the syncarp pilose, so that the syncarp does not appear grooved but instead ridged (Fig. 15). Seed globose; embryo in the centre of the endosperm, linear, subterete, green. Flowering season: evidently extended over a large portion of the year, for both flowers and fruits can be seen on specimens collected at various times of the year. Range: endemic to Kogelberg, where it grows on open but moist south-facing slopes with restiads.

Type: Northwest slopes of Five Beacon Ridge, Kogelberg, *J. P. Rourke 1472* (holotype, RSA; isotype, NBG).

REPRESENTATIVE SPECIMENS

Caledon Division: Sanctuary Peak, near Kogelbaai, *S. MacPherson* 22–VII–1956 (NBG); eastern foothills of Kogelberg above Steenbras Dam, N.W. side, *J. P. Rourke 1374* (NBG), *S. Carlquist 5115* (A, BOL, CAS, K, MO, NBG, PERTH); Kogelberg without specific locality, *T. P. Stokoe 6451* (BOL), *7139* (BOL), *17408* (BOL), *23823* (SAM), *G. J. Lewis 1220* (SAM), *R. H. Compton 7728* (NBG).

I take pleasure in naming this species for Dr. John P. Rourke, Curator of the Compton Herbarium, Kirstenbosch Botanic Garden. Dr. Rourke has explored

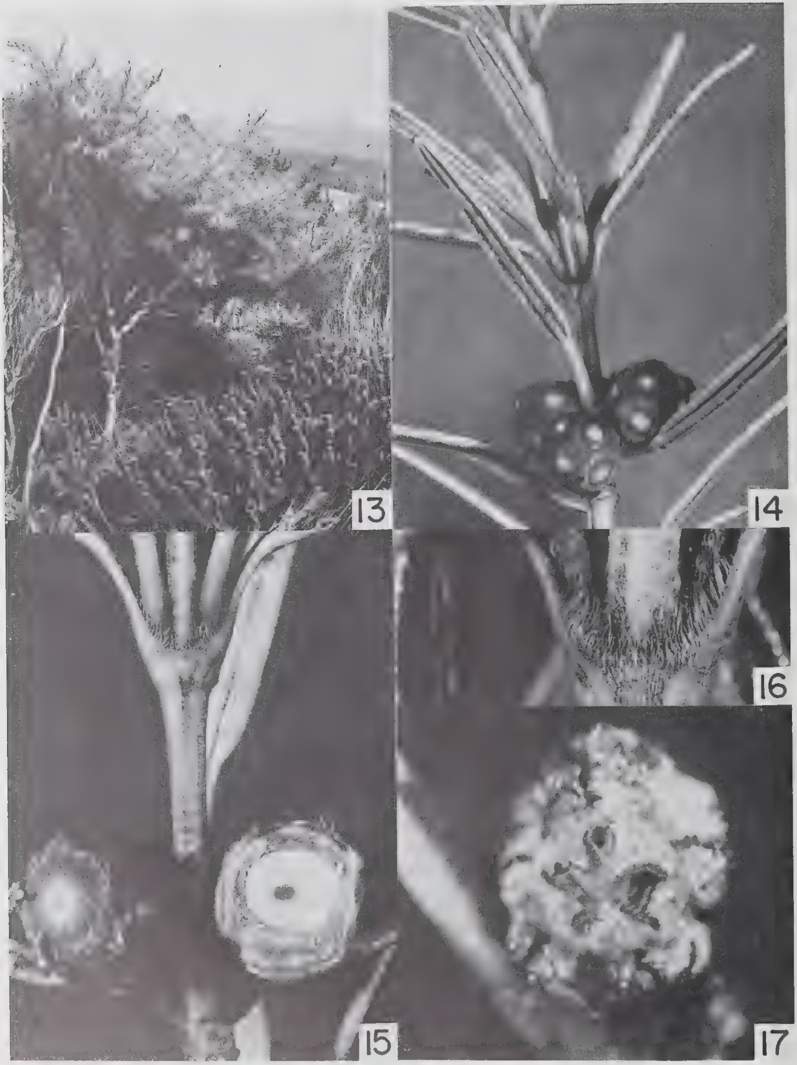

FIG. 13–17.

Grubbia rourkei, S. Carlquist 5115. 13. Habit of shrub 1,3 m high. 14. Branchlet with fruits. X 1,2. 15. Branchlet showing two fruits, one sliced to show the single fertile seed with an embryo in the centre of the white endosperm. X 3. 16. Node, showing long dense hairs. X 15. 17. Inflorescence, with flower apparently at anthesis, pores between overlapping perianth segments. X 20.

Kogelberg in search of colonies of this species and has contributed to knowledge of its range. He kindly showed me a colony of this species, from which my collection and anatomical studies are derived. *Grubbia rourkei* obviously belongs in section *Strobilocarpus*, but is amply distinct from *G. tomentosa*. *Grubbia rourkei* lacks a lignotuber, is branched above the base, with branches spreading in a somewhat horizontal fashion (Fig. 13). The narrowly linear nature of the leaves (Fig. 14) and the densely pilose nodes and petiole bases (Fig. 17) are distinctive. Flowers are deep rose, and apparently do not open in a typical fashion (Fig. 17) if my material is representative. The number of flowers per head is fewer than in *G. tomentosa*, and the syncarp accordingly sphaeroidal (Fig. 14) rather than ovoid, with each fruit demarcated by a pilose groove (Fig. 15), giving a polyhedral rather than smooth oval appearance to the syncarp; the surface of each fruit of the syncarp is red, with a yellowish-green spot in the centre, and pubescent, unlike the glabrous fruits, red-purple at maturity, in *G.tomentosa*. In *G. tomentosa*, the endocarp is evidently thicker.

In lack of a lignotuber, in having fewer flowers per inflorescence than *G. tomentosa*, and in some details of wood anatomy (Carlquist, 1977), *G. rourkei* shows some approach to *G. rosmarinifolia*, despite its obvious affinity to *G. tomentosa*. Division of *Grubbia* into two genera certainly does not seem warranted and indeed, few authors have ever advocated this.

Grubbia rourkei may represent a relict of the stock from which *G. tomentosa*, adapted to drier slopes than the other two species, has developed. Both *G. tomentosa* and *G. rourkei* are relatively uniform morphologically, whereas *G. rosmarinifolia*, despite its ecological restriction to seeps and streams, exhibits diversification among populations, diversification that appears to have been relatively recent. One reason for the diversity in *G. rosmarinifolia* may be the fact that its requirement for summer-wet seeps or streams results in an ''insular'' distribution. On the other hand, *G. tomentosa* forms large, if sparse, populations on slopes subject to fire and greater drought, to both of which factors the lignotuber is doubtless an adaptation. The continuous nature of populations of *G. tomentosa* would, theoretically, result in greater gene-flow and therefore greater uniformity than in a species with ''insular-type'' distribution of populations.

Grubbia tomentosa does grow beneath or among sandstone boulders that would tend to attenuate water availability somewhat, but the capability to form numerous branches from the base permits this species to bear a leafy crown proportionate to its moisture-gathering capacity and moisture availability during particular months. Plants restricted to streams and seeps, such as *G. rosmarinifolia*, are less frequently burned and minimally subject to drought. The scarcity of *G. rourkei* may be related to the fact that although plants occupy moist slopes, these slopes are open, and do dry out and burn during the hottest portions of the year.

One could cite other genera in the Cape flora that show these patterns. For example, *Staavia radiata* (Bruniaceae), like *Grubbia tomentosa*, is a lignotuber-bearing species characteristic of *fynbos* areas subject to drought and fire; it is a relatively widespread species, whereas Staavias that lack lignotubers, such as *S. glutinosa* (Table Mountain) and *S. dodii* (Cape Reserve) are geographically restricted, small in numbers, and may, according to frequency of fires, be very scarce in particular years. Within the open *fynbos* of the Table Mountain Sandstone, resistance to fire by means of lignotubers would seem to be a better long-term strategy for survival than resistance in the form of fire-resistant seeds. This is certain to be true if the increased frequency of fires since human occupation continues.

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WOOD ANATOMY OF GRUBBIACEAE

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ABSTRACT

Comprehensive qualitative and quantitative data, as well as illustrations, are offered for the first time for wood anatomy of all three species of the family Grubbiaceae, as well as for infraspecific taxa. Wood anatomy is of a primitive type. Vessel elements are long with many bars per perforation plate; lateral-wall pitting is alternate on vessel-tracheid contacts, scalariform on vessel-ray contacts. Tracheids have fully bordered pits and are only a little longer—or shorter, in some cases—than the vessel elements for particular organs of each species. This latter situation is extremely rare in dicotyledons, and is difficult to explain. Rays are narrow multiseriate plus uniseriate, with procumbent cells present only in central portions of multiseriate rays. Axial parenchyma is very sparse and diffuse. A rhomboidal crystal or crystals occurs in at least some ray cells. This primitive wood is adapted to the mesic sites in which Grubbiaceae grow, although modification of foliar type also minimizes transpiration and makes mesomorphic wood patterns adaptive. Theories of relationship of Grubbiaceae are reviewed. Placement near Santalaceae has been followed by most authors, and is possible but not firmly supported by data from wood anatomy. The same is true for Ericaceae. However, wood anatomy tends to link Grubbiaceae very closely with Geissolomataceae and Bruniaceae, and to suggest a generalized "rosoid" placement for this trio of families.

UITTREKSEL

DIE HOUTANATOMIE VAN GRUBBIACEAE

Omvattende kwalitatiewe en kwantitatiewe data, asook illustrasies word vir die eerste keer aangebied vir die houtanatomie van al drie species, en die infraspesiese taxa van die familie Grubbiaceae. Houtanatomie is van 'n primitiewe tipe. Vat-elemente is lank met baie balke per perforasieplaat; stippeling van die laterale wande is afwisselend op vat-trachëiedkontakte en leervormig op vat-straalkontakte. Die hofstippels van trachëiede het 'n volledige kraag. Trachëiede is effens langer, of in sommige gevalle korter, as die vat-elemente in dieselfde organe in elk van die species. Laasgenoemde toestand is uiters skaars by dikotiele en is moeilik om te verklaar. Die strale is smal multiseriaal plus uniseriaal met neerliggende selle slegs teenwoordig in die sentrale gedeeltes van multiseriale strale. Aksiale parenchiem is baie min en diffuus. 'n Rhomboïdale kristalle kom in sommige van die straalselle voor. Hierdie primitiewe houttipe pas aan by die mesiese lokaliteite waarin die Grubbiaceae groei, alhoewel modifikasies van die blaartipe, wat transpirasie tot 'n minimum beperk, dit ook moontlik maak vir mesomorfiese houtpatrone om by hierdie toestande aan te pas. 'n Oorsig van die verwantskappe van die Grubbiaceae word gegee. In die meeste gevalle dit naby die Santalaceae geplaas en, alhoewel moontlik, word dit nie sterk ondersteun deur gegewens van die houtanatomie nie. Dieselfde geld ook vir die Ericaceae. Die houtanatomie van die Grubbiaceae dui op 'n noue skakeling met die Geissolomataceae en die Bruniaceae, en suggereer ook die plasing van hierdie trio van families in die „Rosales" (sensu lato).

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INTRODUCTION

Presentation of materials on wood anatomy of Grubbiaceae at the present time has been undertaken for several compelling reasons. First, I was able to collect material of all species in the field. Wood samples of shrubs are rarely collected, and are therefore infrequently present in wood collections. Secondly, I collected materials of roots and lignotubers, structures rarely studied by wood anatomists. Thirdly, had I not collected the wood samples myself, I would have missed understanding the ecology of these species, which proves to be very important in understanding of their woods.

Merely a few scraps of information, qualitative only, have as yet been reported for wood anatomy of Grubbiaceae, as perusal of Van Tieghem (1897), Harms (1935), and Metcalfe and Chalk (1950) shows. The account below is the first to offer complete descriptions and illustrations for wood of the family.

Because of the highly primitive nature of grubbiaceous wood, it is of particular interest for analysis. In addition, the systematic position of Grubbiaceae has been much disputed by those who have studied the family most closely (Van Tieghem, 1897; Harms, 1935; Fagerlind, 1947). Phylogenists dealing with dicotyledons as a whole are in an equally great state of disarray. Wood anatomy does, in fact, prove suggestive if not decisive in establishing the relationships of Grubbiaceae. This topic is discussed in a terminal section of the paper. In a concurrent paper (Carlquist, 1977), taxonomic considerations and ecological observations relevant to the materials below are offered.

MATERIAL AND METHODS

For each species, sections and macerations were prepared from stems of maximal diameter and from roots. The wood of lignotubers of *Grubbia tomentosa* was also sectioned and macerated. In addition, macerations were prepared for a basal stem of *G. rosmarinifolia* subsp. *gracilis*, and for upper branches of *Grubbia rosmarinifolia* subsp. *hirsuta, G. rosmarinifolia* subsp. *rosmarinifolia* var. *pinifolia*, and *G. rosmarinifolia* subsp. *rosmarinifolia* var. *rosmarinifolia*. Specimens documenting these preparations are given in Table 1. Sections were prepared with a sliding microtome and stained with safranin. Macerations were obtained using Jeffrey's Fluid, followed by staining with safranin. For quantitative data, 50 measurements were secured for each feature where possible, and means obtained. Observation on crystal occurrence was made by means of polarized light.

ANATOMICAL DESCRIPTIONS

Grubbia rosmarinifolia subsp. *rosmarinifolia* var. *rosmarinifolia, Carlquist 4508* (Figs. 1–5). Diffuse porous, growth rings minimal. Vessels mostly solitary, averaging 1,14 per group in stem, 1,11 in root. Vessels per sq. mm averaging 206 in stem, 125 in root. Vessel diameter average is 37,8 μ in stem, 47,5 in root. Vessel elements with scalariform perforation plates, averaging 31,7 bars per plate

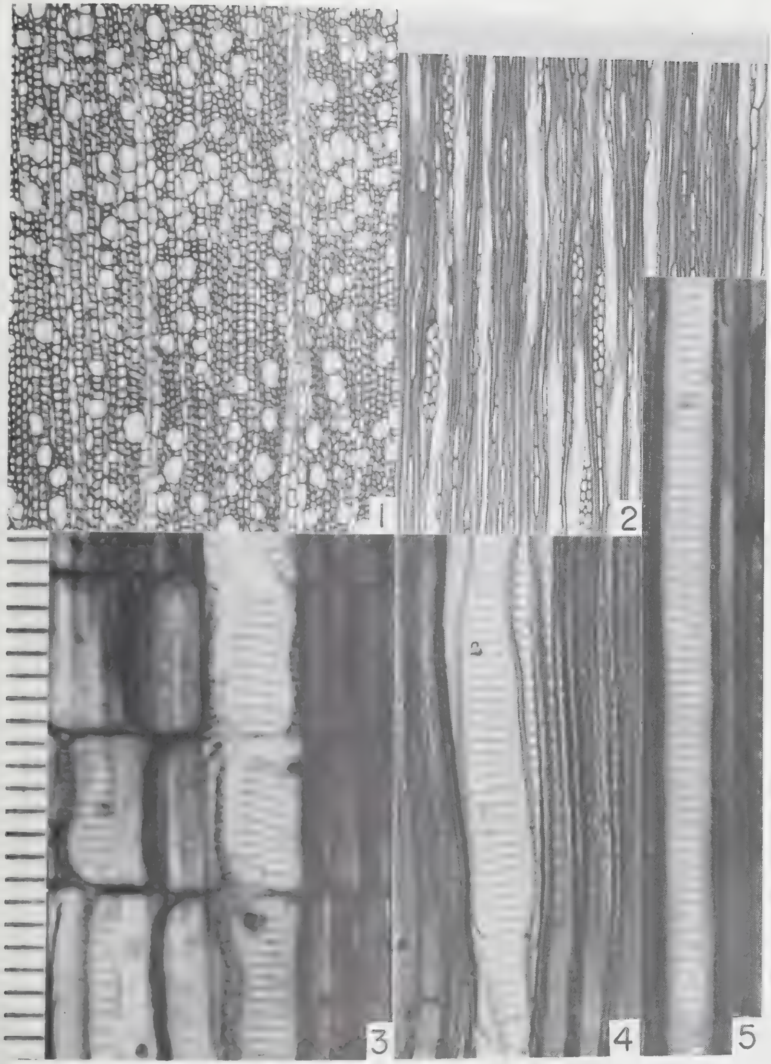

FIG. 1–5.
Grubbia rosmarinifolia subsp. *rosmarinifolia (Carlquist 4508)*, wood sections. 1. Transection, showing a slight fluctuation in vessel density, indicating the imperceptible growth ring activity. 2. Tangential section; multiseriate rays are narrow, few. 3–5. Portions of radial sections: 3. Ray cells, showing scalariform vessel-ray pitting. 4. A relatively short perforation plate. 5. A long perforation plate (nearly the entire length is shown). Magnification shown by photographs of a stage micrometer enlarged at the same scale as applicable photomicrographs. Fig. 1–2, enlarged according to scale above Fig. 2 (finest divisions of scale = 10 μm). Fig. 3–5, scale to left of Fig. 3 (divisions = 10 μm).

in stem (range: 23–43), 32,6 bars in twig (range: 13–55) and 28,2 bars in root (range: 11–47). Vessel element length averages 1 187 μ in stems, 1 183 μ in twig, and 1 176 μ in root. Lateral wall pitting of vessels scalariform to opposite facing rays, sparse, circular and alternate facing tracheids. Tracheid length averages 1 190 μ in stem, 1 155 μ in twig, and 1 220 μ in root. Tracheid wall thickness averages 2,6 μ in stem, 2,6 μ in root. Pits of tracheids have elliptical apertures shorter than the diameter of the pit cavity. Axial parenchyma very sparse, diffuse; one band seen at the single growth ring observed. Both multiseriate and uniseriate rays present; procumbent cells present only in the central portion of multiseriate rays, sheathing cells and those of the uniseriate rays square to upright. Multiseriate rays average 453 μ in height in stem, 583 μ in root; multiseriates average 2,7 cells at widest point in stem, 3,2 cells in root. Uniseriate rays average 213 μ in height in stem, 158 μ in root. Ray cells various in wall thickness, thick-walled in some ray cells of the stem. Rhomboidal crystals solitary in a very few ray cells of the stem, but also present in ray cells in root. Droplets of unidentified gummy materials in ray cell of stem and root; some massive deposits in some ray cells of stem.

Macerations of twigs from specimens representing infraspecific taxa of *G. rosmarinifolia* provided the following data: subsp. *rosmarinifolia* var. *rosmarinifolia, Compton 14381* (SAM): vessel elements average 821 μm in length, 26,6 bars per perforation plate, tracheids average 884 μm in length; *G. rosmarinifolia* subsp. *rosmarinifolia* var. *pinifolia, Stokoe 57840* (SAM): vessel elements average 1 118 μm in length, 32,4 bars per perforation plate, tracheids average 1 189 μm in length; *G. rosmarinifolia* subsp. *gracilis* (basal stem or large twig), *Lewis 1321* (SAM): vessel elements average 880 μm in length, 19,9 bars per perforation plates, tracheids average 930 μm in length; *G. rosmarinifolia* subsp. *hirsuta, Esterhuysen 10908* (BOL): vessel elements average 1 036 μm in length, 28,4 bars per perforation plate, tracheids average 1 158 μm in length.

The very long perforation plates of *Grubbia rosmarinifolia* are not always perfectly scalariform; they range from virtually perfect (Fig. 4) to a condition in which one or two bars fuse (or can be described as forked), as can be seen in Fig. 5, below.

Grubbia rourkei, Carlquist 5115 (Fig. 6–9, 17, 18). Growth rings inconspicuous, only one seen in a stem at least 15 years old; diffuse porous. Vessels mostly solitary, averaging 1,14 per group in stem, 1,15 in root. Vessels per sq. mm. average 246 in stem, 88 in root. Vessel diameter averages 39,9 μm in stem, 53,7 μm in root. Vessel elements with scalariform perforation plates, averaging 26,3 bars per plate in stem (range: 16–35), 23,3 bars per plate in root (range: 16–33). Vessel element length averages 1 267 μm in stem, 796 μm in root. Lateral wall pitting is scalariform on vessel-ray contacts, opposite or alternate circular pits on vessel-tracheid contacts (Fig. 17). Tracheid length averages 1 239

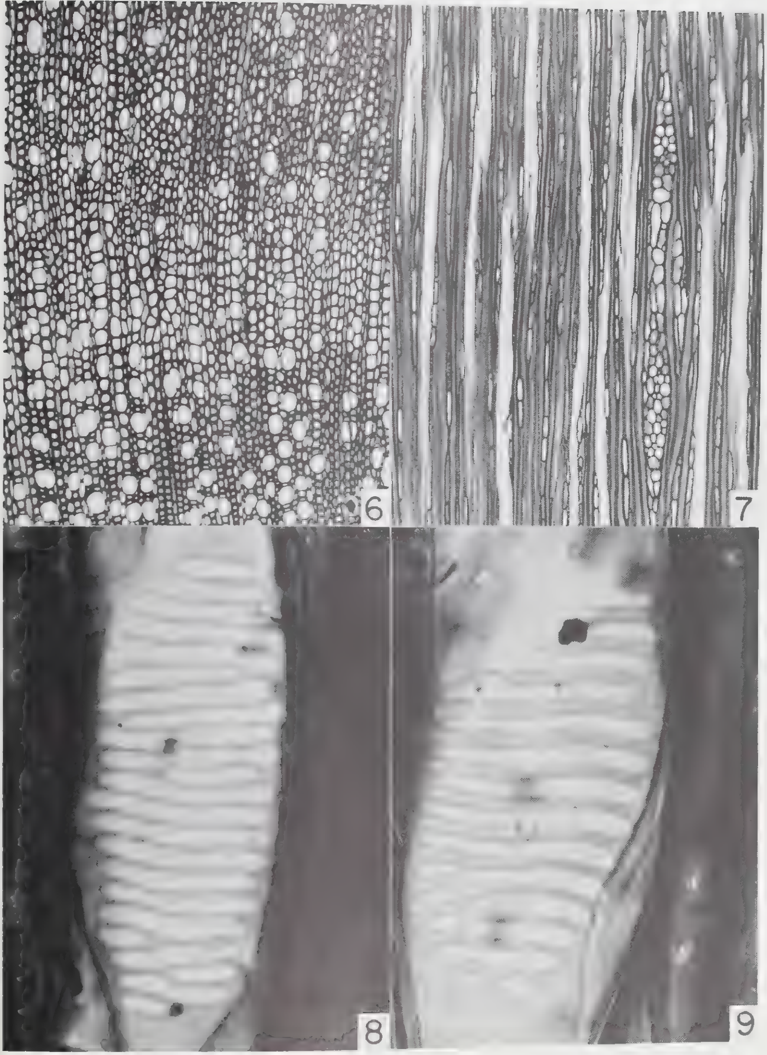

Fig. 6–9.

Grubbia rourkei (Carlquist 5115), wood sections. 6. Transection; a growth ring, center, is visible. 7. Tangential section; multiseriate ray at right. 8. Entire perforation plate. 9. Perforation plate portion showing borders on bars; tracheid pits visible lower right. Fig. 6, 7, magnification according to scale above Fig. 2. Fig. 8, 9, magnification according to scale at right of Fig. 15.

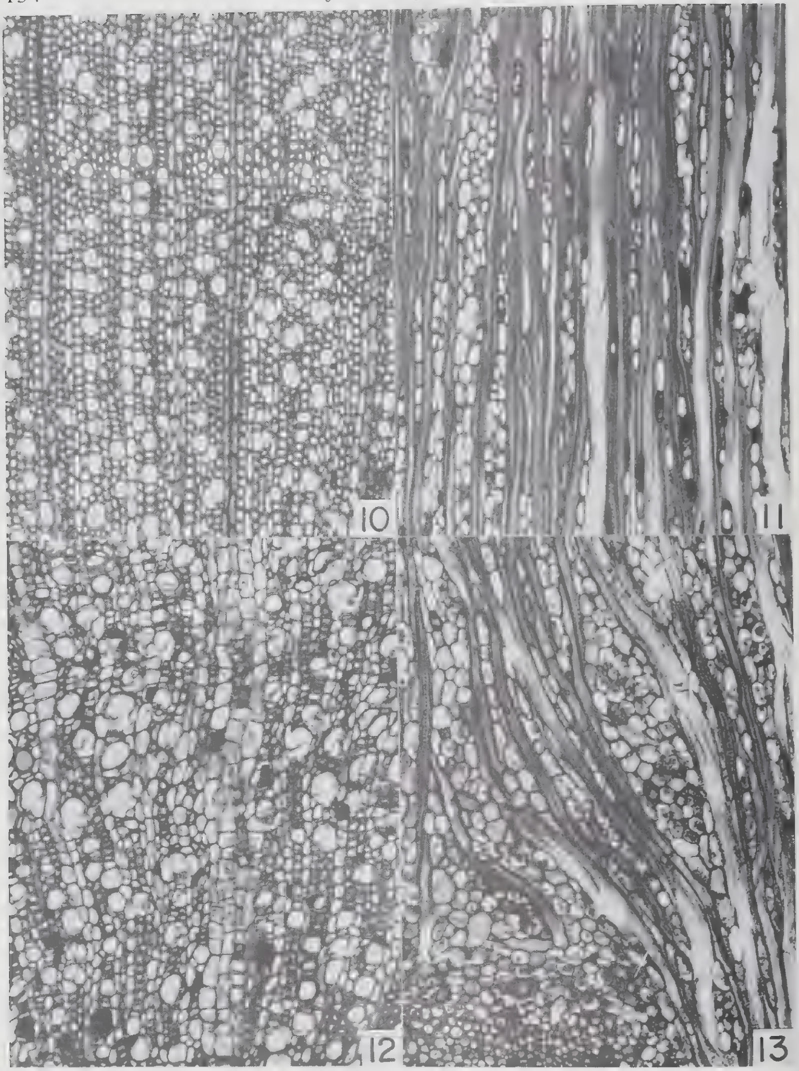

FIG. 10–13.
Grubbia tomentosa (Carlquist 4515), wood sections. 10–11. Sections from upright aboveground shoot. 10. Transection; no growth ring activity visible. 11. Tangential section. 12–13. Sections from root. 12. Transection. Vessels are relatively large, tracheids fewer compared to stem wood. 13. Tangential section. Rays and ray cells are larger and bulk larger in root wood as compared to that of stem. Fig. 10–13, magnifications according to scale above Fig. 2.

μm in stem, 985 μm in root. Tracheids have elliptical apertures shorter than the diameter of the pit cavity. Axial parenchyma very scanty, diffuse. Both multiseriate and uniseriate rays present; multiseriates have procumbent cells in centre of rays only. Multiseriate rays average 808 μm in stem, 590 μm in root. Multiseriate rays average 2,7 rays at widest point in stem, 2,2 cells in root. Uniseriate rays more abundant than multiseriates, averaging 455 μm in height in stem, 329 μm in root. Uniseriate rays composed wholly of square to procumbent cells, erect cells predominant. Ray cell walls vary in thickness; many are notably thick-walled and have borders formed on pits (Fig. 18). Rhomboidal crystals solitary in occasional ray cells in stem and root. Massive deposits and droplets of unidentified gummy materials in ray cells (Fig. 18).

Forking of bars and other minor anomalies of the scalariform perforation plates are shown in Fig. 8 and 9. The perforation plates shown there are shorter than the average, because of the difficulties in photographing long perforation plates, portions of which are usually cut away in sectioning. Bars on some perforation plates bear borders along the length of the bars (Fig. 9).

Grubbia tomentosa, Carlquist 5010 (Fig. 10–16). Growth rings barely perceptible, diffuse porous. Vessels mostly solitary, averaging 1,10 per group in stem, 1,08 in root. Vessels per sq. mm average 139 in stem, 121 in root. Vessel diameter averages 43,2 μm in stem, 54,0 μm in root and 59,0 μm in the lignotuber. Vessel elements with scalariform perforation plates, perforation plates averaging 30,8 bars per plate in a small stem, 30,0 bars in a large stem (range: 24–41), and 29,9 bars in the root (range: 21–51); number of bars averages 24 in the lignotuber, but sample too small to be conclusive. Vessel element length averages 1 014 μm in the stem, 1 096 μm in twig, 1 069 μm in the root, and 755 μm in the lignotuber. Lateral wall pitting of vessels scalariform facing rays; sparse, circular and alternate facing tracheids. Tracheid length averages 1 106 μm in a twig, 1 139 μm in a large stem, 1 302 μm in the root, and 757 μm in the lignotuber. Tracheid wall thickness averages 3,5 μm in stem and 4,4 μm in the root. Tracheid pits elliptical to circular, the length of the aperture shorter than the diameter of the pit cavity. Axial parenchyma very sparse, diffuse. Both multiseriate and uniseriate rays present, multiseriate rays more abundant than uniseriates (Figs. 11, 13). Multiseriate rays of the stem contain procumbent cells in the central portion of the rays, but procumbent cells are more abundant in the wide rays of the root (Fig. 13); other cells of multiseriate rays square to erect. Multiseriate rays average 1 271 μm in height in the large stem, 731 μm in the root. Multiseriate rays average 3,7 cells at widest point in the stem (Fig. 11), 4,0 cells in the root. Uniseriate rays average 316 μm in height in the large stem, 273 μm in the root; uniseriates composed of square to erect cells only. Crystals one or more per cell in many ray cells of root (Figs. 14–16), and in some ray cells of the large stem and the lignotuber. Smaller crystals also present in some cells along with the larger crystals (Figs. 14, 15).

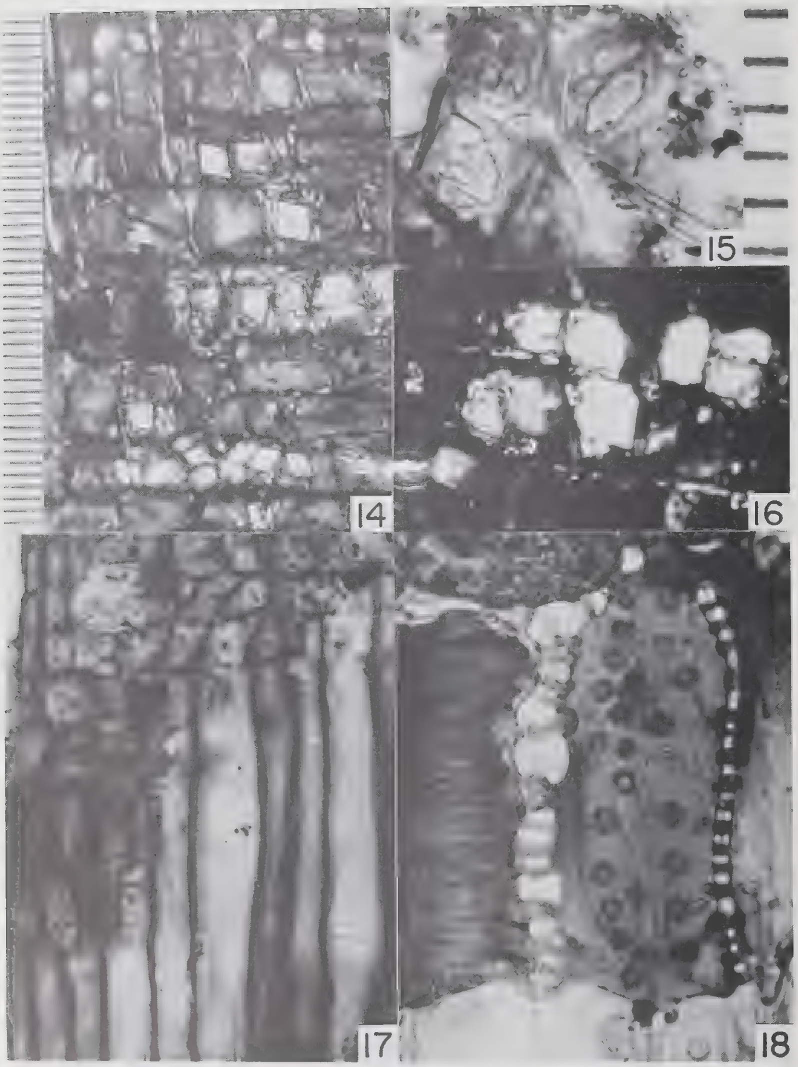

FIG. 14–18.

Details of wood histology of *Grubbia* species as seen on radial sections. 14–16. *Grubbia tomentosa (Carlquist 4515),* views of crystals in ray cells of root wood. 14. Portion of ray in partially polarized light, showing crystal density in this tissue. 15. Rhomboidal crystals of various sizes seen in non-polarized light. 16. Rhomboidal crystals of various sizes seen in fully polarized light. 17–18. *Grubbia rourkei (Carlquist 5115).* Sections from stem wood. 17. Portions of ray above and at left; vessel-ray and intervascular pitting on vessel at right. 18. Portions of ray cells to show thickened wall with bordered pits and deposits of dark-staining gummy substance. Fig. 14, 17, magnification according to scale at left of Fig. 14. Fig. 15, 16, 18, magnification according to scale at right of Fig. 15.

Dark-staining deposits of unidentified gummy materials present in ray cells of the stem (Fig. 11), root (Figs. 12, 13) and the lignotuber, and in some vessels of the root (Fig. 12).

TABLE 1

Wood characteristics in *Grubbia*

Species, portion	*Collection*	*Vessel diameter, mean, μm*	*Bars per perforation plate, mean*	*Ratio of mean tracheid length to vessel element length*	*Vessel element length, mean, μm*
G. r. r. var. *rosmarinifolia*[1]	Carlquist 4508[1]				
large stem		37,8	31,7	1,002	1 187
root		47,5	28,2	1,04	1 176
twig			32,6	0,98	1 182
twig	R. H. Compton 13481		28,6	1,08	821
G. r. r. var. *pinifolia*	T.P. Stokoe 57840				
twig			32,4	1,06	1 189
G. rosmarinifolia subsp. *gracilis*	G.J. Lewis 1321				
stem base			19,9	1,06	880
G. rosmarinifolia subsp. *hirsuta*	E. Esterhuysen 10908				
twig			28,4	1,12	1 036
G. rourkei	Carlquist 5115				
main stem		39,3	26,3	0,98	1 267
main root		53,7	23,3	1,24	796
G. tomentosa	Carlquist 4515				
large stem		43,2	30,0	1,12	1 014
large root		54,0	30,0	1,22	1 069
lignotuber		49,1	24,0	0,997	755
twig			30,8	1,01	1 096

[1] For nomenclatural and herbarium citations, see a concurrent paper (Carlquist, 1977).

DISCUSSION OF ANATOMICAL FEATURES

Growth Rings

Despite the seasonality of the climate of Cape Province, only minor fluctuation in vessel diameter and abundance can be seen in the woods of *Grubbia* (Figs. 1, 6, 10, 12). The one pronounced growth ring observed in *G. rourkei* may have been related to an unusually severe season. However, lack of growth rings in such mesomorphic woods is to be expected, especially considering that the habitats of all species (especially *G. rosmarinifolia*) are mesic throughout the year or have very attenuated water supply. Also, the evergreen leaves with reduced surface area, revolute margins, abaxial pubescence and varnish-like coating (notably in *G. rourkei*) suggest minimal fluctuation in transpiration.

Vessel Elements

As Table 1 shows, vessel elements in Grubbiaceae are relatively long compared to those of dicotyledons as a whole, although somewhat shorter than the average length in the primitive woods sampled in comparable woods (Carlquist, 1975a, p. 141), perhaps because *Grubbia* is shrubby, whereas the woods of my 1975a sample came mostly from trees. In comparing the species of *Grubbia*, one should remember that the wood samples, although of maximally large diameter for main stems and roots in their respective species, were not identical in size: the largest stem of *G. tomentosa* I could find was about 1 cm in diameter, whereas the base of the main stems of *G. rourkei* and *G. rosmarinifolia* subsp. *rosmarinifolia* var. *rosmarinifolia* I collected were about 3 cm in diameter. *Grubbia tomentosa* has smaller stems because numerous shorter-lived stems branch from the lignotuber. The somewhat shorter vessel element length reported for *G. tomentosa* (Table 1) might reflect this, because vessel element length tends to increase with age of a stem (Bailey and Tupper, 1918). The short vessel elements of the lignotuber are probably related to the contorted nature of the wood, for contorted wood tends to have shorter tracheary elements (Bailey and Tupper, 1918). The data of Table 1 tend to show that in comparing twigs with main stems there is no marked increase, and that only moderate increase in vessel element length with age occurs. The short vessel elements in roots of *G. rourkei* run counter to the general trend in dicotyledons, namely, vessel elements longer in roots compared to stems, as far as is known (Carlquist, 1975a, p. 179). Perhaps the contorted nature of roots may result in a shorter vessel element length than otherwise would be the case. However, the tendency of vessel elements to be wider in roots than in stems (Carlquist, 1975a, p. 179) does hold in Grubbiaceae.

In the book cited, I held that a low tracheid length: vessel element length ratio in a species can be regarded as a rough index of primitiveness. These ratios (Table 1) are remarkably low in Grubbiaceae. The occurrence of ratios lower than 1,00 in Grubbiaceae (twigs of *G. rosmarinifolia* subsp. *rosmarinifolia* var. *rosmarinifolia*; lignotuber of *G. tomentosa*) as well as ratios extremely close to 1,00 (Table 1) suggests that an additional factor may be operative. Such low ratios (below 1,00) have not been reported in earlier work (Bailey and Tupper, 1918; Carlquist, 1975a) on dicotyledons, although I have found ratios below 1,00 in *Myrothamnus* (Carlquist, 1976a) and certain Bruniaceae (Carlquist, unpublished data). Perhaps the vessel elements have a greater intrusive capacity in Grubbiaceae and elongate more, compared with the length of fusiform cambial initials from which they were derived, than is typical for dicotyledons. Although vessel elements in dicotyledons at large are often thought to be about the same length as their respective parental fusiform cambial initials, at least some elongation does take place, on the average. I am hesitant to offer an explanation for the ratios at or below 1,00. That several such ratios have now been computed, both in Grubbiaceae and elsewhere, shows that mere sampling error is not involved. As one hypothesis, one could suggest that *Grubbia* does not have longer vessel elements than could have been predicted, but shorter tracheids. If, as hypothesized, tracheary element length is proportional to strength (Carlquist, 1975a, p. 88), the shrubby habit of Grubbiaceae, and especially the lignotuber of *G. tomentosa*, may be correlated with less elongate (and therefore less maximally strong) tracheids than would be the case in arboreal dicotyledons. There is, however, no truly convincing reason to advance this hypothesis at present, for shrubby and herbaceous dicotyledons do have imperforate elements longer than vessel elements in species that have been studied, with the few exceptions noted.

Perforation plates in *G. rosmarinifolia* may seem abnormally long when wood sections are viewed (e.g., Fig. 5), but shorter ones are also present in that species (Fig. 4). In fact, as the data of Table 1 show, there is not a marked difference among the species. Borders can be seen on bars, either along the length of each bar (Fig. 9) or as vestigial borders at the ends of each perforation (Fig. 8).

Lateral wall pitting is scalariform opposite ray cells (Fig. 3, 17), but consists of sparse circular bordered pits elsewhere. The presence of scalariform pitting seems to bear a relation to the extremely low density of axial parenchyma in *Grubbia*. If axial parenchyma is scarce or absent, rays may possess the function of both vertical and lateral photosynthate translocation in wood and maximal vessel-ray contacts by means of scalariform pitting may be of selective value. This, if true, could be considered an addendum to my hypothesis about the nature of vessels in primitive wood (1975a).

If one compares vessel element length, vessel width, and number of bars per perforation plate for species and organs in Table 1, one finds all of these are roughly proportional. Shorter, wider vessel elements tend to have fewer bars per perforation plate (e.g., *G. tomentosa* lignotuber). The ranges in these features are not great within the genus. The short vessel elements, with fewer bars per perforation plate, as well as short tracheids, in *G. rosmarinifolia* subsp. *gracilis*, are probably correlated with the diminutive, almost stunted stature of plants in that subspecies.

Vessels tend to be midway between angular and round in transection (Fig. 1, 6, 10, 12), and as figures for vessels per group in the descriptions illustrate, vessels are nearly all solitary. These expressions qualify as primitive according to traditional theories of wood evolution in dicotyledons.

Tracheids

Tracheids are not notably thick-walled in *Grubbia* (Fig. 1, 6, 10, 12) as compared to those of other primitive woods, such as that of *Illicium* (Carlquist, 1975a). Moderately thick-walled tracheids characterize the South African shrub *Geissoloma* as well (Carlquist, 1975b). All tracheids in *Grubbia* have pit apertures slit-like, but no longer than the pit cavity diameter (Fig. 9), and there is no doubt as to their identity as tracheids.

Axial Parenchyma

Axial parenchyma is extremely scanty in woods of Grubbiaceae, although I observed it in all organs of all three species. Axial parenchyma is slightly more abundant in *G. rourkei*. The paucity of axial parenchyma in stems of *Grubbia* may be related to their relatively finite size (aerial stems rarely if ever exceed 3–4 cm in diameter). This explanation was suggested for another South African shrub, *Myrothamnus flabellifolia*, which lacks axial parenchyma and which also never becomes a large shrub (Carlquist, 1976a). Conceivably, an axial parenchyma system can be superseded by abundance of erect ray cells if a plant (or shoots from a lignotuber) are of relatively finite duration.

Rays

Both multiseriate and uniseriate rays are present in all species. Multiseriates are wider and more abundant in *G. tomentosa* stems, roots, and especially lignotubers (Fig. 11, 13). Because of the habit of *G. tomentosa*, a higher proportion of ray tissue to mechanical tissue compared with *G. rosmarinifolia* and *G. rourkei* might be expected. The lignotubers and roots of *G. tomentosa* also have a definite storage capacity to survive burning and perhaps drought, so that greater abundance of parenchyma might be expected.

Procumbent cells are relatively infrequent in rays of all *Grubbia* species (Fig. 17). A few occur in central portions of multiseriate rays. Relative abundance of upright ray cells can be regarded as a substitute for paucity of axial parenchyma cells, as mentioned above. Uniseriate rays composed of erect to square cells, or erect cells exclusively, are relatively infrequent in dicotyledons, but occur in shrubs such as *Roridula* (Carlquist, 1976b) and may function in vertical translocation of photosynthates, as mentioned above.

Thick-walled ray cells may be found in stems in some rays of *G. tomentosa* and *G. rourkei* (Fig. 18). I have hypothesized (Carlquist, 1975a, 1975b) that thick-walled ray cells with bordered pits may represent a simple mechanism for increasing mechanical strength of a wood. This can apparently occur easily phylogenetically, and does not always occur in primitive woods.

Crystals

Crystals are most conspicuously present in ray cells of *G. tomentosa* (Fig. 14–16). They are less common in the two other species, and very rarely seen in axial parenchyma cells. These crystals take the form of one, sometimes more, rhomboidal crystals per cell. If more than one crystal per cell is present, one is large and the others much smaller. This was observed in *Geissoloma* (Carlquist, 1975b), and may also be observed in many Bruniaceae (Carlquist, unpublished data).

Gummy Deposits

As in *Geissoloma* and in Bruniaceae, gummy deposits, chiefly in ray cells (Fig. 11, 12, 13, 17, 18) but also, if abundant, in vessels, occur in Grubbiaceae. These deposits are least conspicuous in *G. rosmarinifolia.*

ECOLOGICAL INTERPRETATIONS

The habitats of the *Grubbia* species are distinctive: *G. rosmarinifolia* in montane seeps and streams; *G. rourkei* on moist slopes of Kogelberg; and *G. tomentosa* on south-facing slopes at lower elevations, in open scrub but almost invariably beside or among sandstone blocks that tend to provide pockets for moisture accumulation and retention. The lignotubers of *G. tomentosa* may also be regarded as a system moderately capable of water storage, and the pattern of numerous shoots innovated from the lignotuber provides a means of producing branches and foliage in amount appropriate to the wetness of the season. Fire and dieback from severe drought would not be fatal for *G. tomentosa*, for the lignotuber can provide new shoots indefinitely. Indeed, I suspect some individuals of *G. tomentosa* are quite old, judging from the massive size of lignotubers, which eventually fragment into several adjacent and independent portions. Deep roots in this species probably tap water well below the surface compared with the ericads, restiads, etc. with which *G. tomentosa* may be found growing. In short, *G. tomentosa* may be regarded as a plant adapted to maintenance of a mesomorphic system within a basically dry mediterranean-type climate, just as a desert annual is a mesophyte that grows only during a mesic portion of a wet year.

The various features of *Grubbia* plants seem well designed for utilization of a "primitive" or "inefficient" conductive system in which rates of flow are probably slow and in which excessively high water tensions do not develop. *Grubbia*, like *Geissoloma* (Carlquist, 1975b), *Roridula* (Carlquist, 1976b), and Bruniaceae, probably represents a relictual group, at least with respect to xylem, that has persisted in relatively mesic pockets within the otherwise rather xeromorphic flora of the Table Mountain Sandstone.

PHYLOGENETIC CONSIDERATIONS

The affinities hypothesized by various authors may be summarized under the following headings.

1. Santalaceae and Santalales

The single perianth whorl, valvate aestivation of flowers, and inferior ovary of *Grubbia* probably provided the chief bases for this supposed relationship to which such authors as Bartling, Bentham, and Hieronymus subscribed earlier (see Fagerlind, 1947), and which is perpetuated in the more recent systems such as those of Wettstein (1935), Hutchinson (1959), and Cronquist (1968). The wood anatomy of Grubbiaceae is not totally incongruent with that of Santalaceae because Santalaceae do have tracheids as imperforate elements and prominent crystals in axial parenchyma, but they have vessels with simple perforation plates exclusively and also have vascular tracheids (Metcalfe and Chalk, 1950). The reader who wishes information on how vascular tracheids differ from true tracheids may consult Carlquist (1961, 1975a). The degree of xylary specialization separates it markedly from Grubbiaceae, and one would perhaps be better advised to look toward groups in which the wood is not so highly different in level of specialization, rather than assume extinction of all intermediate wood types. If Grubbiaceae were related to Santalaceae, one might expect that in Africa there might be santaloids that approach Grubbiaceae either in gross morphology or in anatomy, but none appear to do so.

2. Ericaceae

Fagerlind (1947) presents a detailed argument for this relationship, and cites precedent in the work of Bergius, Jussieu, St. Hilaire and Hedwig. Some of these authors probably were more influenced by the ericoid appearance of herbage of *Grubbia rosmarinifolia* than by any deep-seated resemblances. Erdtman (1952) lends a degree of support to supposed ericaceous affinity on the basis of pollen. However, one must remember that neither Grubbiaceae nor Ericaceae offer any highly distinctive features in pollen grains, and have a generalized type common to many dicotyledonous families. Moreover, Erdtman's work was done prior to the advent of electron microscopy, which now offers much more precise and detailed information. Although Fagerlind cites a number of resemblances between Ericaceae and Grubbiaceae, all of the features mentioned are rather widespread in dicotyledons, and are not convincing separately or collectively. The abundance of Ericaceae in South Africa is not really phytogeographic evidence at all, for the South African ericads seem highly specialized, as evidenced by their wood, whereas ericad phylads with wood comparable in level of specialization to that of *Grubbia* are in remote localities in the northern hemisphere. The floral morphology of Ericaceae is also markedly different from that of Grubbiaceae. Fagerlind is forced to describe similarities in terms of floral diagrams rather than detailed features of histology. I do not find evidence for an Ericaceae—Grubbiaceae relationship compelling.

3. Hamamelidaceae

Floral morphology, with respect to number and kinds of parts, has been suggestive to authors who have construed a relationship between Grubbiaceae and Hamamelidaceae. The names of Decaisne, Gardner, and Sonder (see Van

Tieghem, 1897) can be cited in this regard. The wood of Hamamelidaceae offers many similarities to that of Grubbiaceae, and is to me indicative of a degree of relationship, but one more remote than the ones discussed below. Hamamelidaceae may be regarded as a "rosoid" or "rosalean" family not far removed from the familial groupings discussed below.

4. Bruniaceae

Although Van Tieghem (1897) concluded that Grubbiaceae is allied to Bruniaceae, he has precedent in Arnott, Endlicher, Lindley, and Agardh, whereas A. de Candolle regarded Bruniaceae as a link between Santalaceae and Grubbiaceae (see Van Tieghem). One must stress that rosoids in the broad sense would include Hamamelidaceae. The concept that Grubbiaceae is allied to Bruniaceae has been most recently re-adopted by Thorne (1968), who places the South African families Bruniaceae, Geissolomataceae, Hydrostachyaceae, Myrothamnaceae, and Roridulaceae in a suborder, Brunineae, of Pittosporales. His order Pittosporales falls under a superorder, Rosiflorae, which Thorne places next to the superorder Hamamelidiflorae.

Close resemblance may be found between the woods of Grubbiaceae and Geissolomataceae, and comparison of photographs in the present paper and those in my (1975b) study of *Geissoloma* wood will reveal striking resemblances. The same applies to Bruniaceae, the woods of which I have studied, and on which I have amassed considerable qualitative and quantitative data soon to be published. I can state that in Bruniaceae a number of species match one or more of the three species of *Grubbia* so closely in wood anatomy that I might not be able to separate unlabelled slides of wood sections accurately into their respective families. I feel that more than parallelism is involved. The element of phytogeography is suggestive: Thorne's Brunineae are essentially South African (with extension into Madagascar) and all (except Hydrostachyaceae) have secondary xylem of a primitive nature. However, features other than these are persuasive, as Van Tieghem (1897) showed in a preliminary way. I hope to broaden the basis of a phylogenetic interpretation. For the present, however, I can state that resemblances in wood anatomy among Grubbiaceae, Bruniaceae, and Geissolomataceae are very close; although more features than wood anatomy are required to collate these families into ordinal groupings, the wood anatomy does at least confirm a generalized "rosoid" position of Grubbiaceae along with Geissolomataceae and Bruniaceae.

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A SYSTEMATIC CHECK LIST OF THE SPERMATOPHYTA OF THE BAAKENS RIVER VALLEY, PORT ELIZABETH

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Abstract

The vegetation of the Baakens River Valley is briefly discussed. The 306 indigenous species recorded are listed in a systematic check list. Of the 77 Angiospermae families recorded, the Compositae (33 spp.), Liliaceae (19 spp.), Gramineae (16 spp.), Leguminosae (16 spp.) and Iridaceae (15 spp.) are those best represented. The Gymnospermae is represented by one species only. The total indigenous flora is threatened by alien species.

Uittreksel

'N SISTEMATIESE KONTROLELYS VAN DIE SPERMATOPHYTA VAN DIE BAAKENSRIVIERVALLEI, PORT ELIZABETH

Die plantegroei van die Baakensriviervallei word kortliks bespreek. Die 306 inheemse spesies wat aangeteken is, word weergegee in 'n sistematiese kontrolelys. Van die 77 Angiospermae families wat aangeteken is, is die volgende die beste verteenwoordig: Compositae (33 spp.), Liliaceae (19 spp.), Gramineae (16 spp.), Leguminosae (16 spp.) en Iridaceae (15 spp.). Die Gymnospermae word verteenwoordig deur slegs een spesie. Die totale inheemse flora word bedreig deur uitheemse spesies.

Introduction

The Baakens River is a short river, approximately 15 km long, starting in the Kabega Park area and winding its way in an easterly direction through Fairview, Sunridge Park, Fern Glen, Glen Hurd, Newton Park, Linkside, Mill Park and Walmer, through Settlers Park, reaching the sea in the harbour area (Fig. 1).

Interest was focused on the Baakens River Valley in 1959 when plans for a freeway were mooted. It was then realized that the valley was extremely rich in fauna and flora, with a unique position in an urban area.

Since then several abortive attempts were made to declare as a nature reserve the whole valley or at least the area between Frame's Drift and Target Kloof where two municipal reserves had already been in existence, one in the Linkside—Mill Park area and one in the Glen Hurd—Newton Park area.

The most recent attempt to safeguard the area was made in 1973 when negotiations were started to establish a botanic garden in the Sunridge Park—Fern Glen area.

As it is essential to have a reasonable knowledge of species occurring within a protected area, and as very little floristic data were available this survey was undertaken.

It deals with the area between Frame's Drift and Target Kloof.

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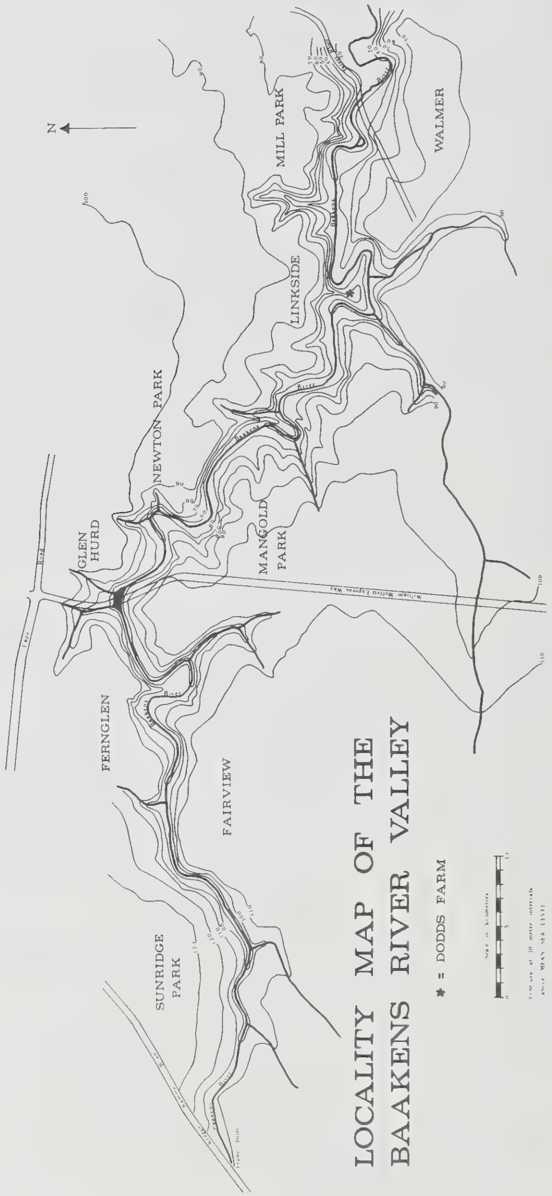

FIG. 1
Locality Map of the Baakens River Valley, Port Elizabeth

METHODS

During the period 1974–1975 the area was visited at regular intervals and specimens were collected in triplicate. Two sets were sent to the Compton Herbarium, Kirstenbosch for identification. The third set is housed in the herbarium of the University of Port Elizabeth (PEU).

RESULTS AND DISCUSSION

Vegetation

Two distinct vegetation types can be recognised in the area:

1. Forest and bush
2. Fynbos

1. Forest and bush

Forest areas are more or less restricted to the kloofs and south facing slopes and cliffs, the approximate height being 6–7 metres. In drier and more exposed habitats it merges into bush of an approximate height of 4 metres. Some 30 species which may by classified as trees or shrubs occur in these areas. *Ekebergia capensis, Olea capensis* subsp. *capensis, Pittosporum viridiflorum, Pterocelastrus tricuspidatus, Colpoon compressum, Hippobromus pauciflorus, Sideroxylon inerme, Tarchonantus camphoratus, Smelophyllum capense* and *Scutia myrtina* are of general occurrence.

2. Fynbos

This vegetation type is found on the open hillsides on the northern and southern sides of the valley, the north-facing areas being much drier than the south-facing. In these areas a large number of species belonging to the Liliaceae, Iridaceae, Orchidaceae, Leguminosae and Compositae were found. Proteads are represented by the following three species: *Protea neriifolia, Leucospermum cuneiforme* and *Leucadendron salignum* and the Ericaceae by five *Erica* spp., viz. *Erica cerinthoides, E. decipiens, E. glandulosa, E. pectinifolia* and *E. simulans.* On rocky outcrops the vegetation is open with a distinct succulent character.

Both these vegetation types are shrinking fast as the exotics advance and relatively few unspoilt areas remain. The least spoilt of the forest areas are those in the municpal reserves and an area below Sunridge Park where a community of *Podocarpus falcatus* survives. Beyond Fairview and Fern Glen undisturbed bush with numerous *Aloe pluridens* still exists. The best preserved fynbos area is west of the William Moffett Express Way, below Fern Glen.

Along its entire length, the river bed is inundated with aliens, the occasional tree (especially *Ekebergia capensis* and *Tarchonantus camphoratus*) still holding its own, whilst patches of *Phragmites australis* indicate the water course. Few permanent pools have remained; one at the end of Alcock Road, Walmer and another near Target Kloof bridge, being the only ones of considerable size.

Flora

The indigenous Angiospermae of the Baakens River Valley accounts for 77 families, 205 genera and 305 species. The Gymnospermae is represented by one species only. *Encephalartos horridus* which, until a few years ago, used to grow in the area, no longer occurs there.

Twenty-three alien species are recorded.

An analysis of the 77 Angiosperm families indicates that 12 (15,58%) are monocotyledons and 65 (84,42%) are dicotyledons. Of the Angiosperm species 77 (25,25%) are monocotyledons and 228 (74,75%) are dicotyledons. There are 21 (27,27%) families whose species contribute more than 1,5% of the total number of species and these are listed in order of numerical importance in Table 1. Thirty-one (40,26%) families are represented by one species only, 12 (15,58%) families are represented by two species, 7 (9,09%) by three species and 6 (7,79%) by four species.

TABLE 1:
Synopsis of the families whose species comprise more than 1,5% of the total number listed in order of numerical importance, together with the number of genera in each family.

Family	No. of species	No. of species expressed as a % of total	No. of genera	No. of genera expressed as a % of total
Compositae	33	10,82	23	11,22
Liliaceae	19	6,23	10	4,88
Gramineae	16	5,25	13	6,34
Leguminosae	16	5,25	10	4,88
Iridaceae	15	4,92	10	4,88
Aizoaceae	10	3,28	7	3,41
Anacardiaceae	10	3,28	1	0,49
Scrophulariaceae	10	3,28	9	4,39
Celastraceae	9	2,95	4	1,95
Crassulaceae	7	2,30	2	0,98
Campanulaceae	7	2,30	6	2,93
Amaryllidaceae	6	1,97	5	2,44
Orchidaceae	6	1,97	6	2,93
Ebenaceae	6	1,97	2	0,98
Cyperaceae	5	1,64	4	1,95
Geraniaceae	5	1,64	1	0,49
Rutaceae	5	1,64	3	1,46
Euphorbiaceae	5	1,64	2	0,98
Malvaceae	5	1,64	3	1,46
Thymelaeaceae	5	1,64	3	1,46
Ericaceae	5	1,64	1	0,49

SYSTEMATIC LIST

The systematic list is arranged according to Phillips (1951). (The numbers following the species names refer to the author's collecting numbers).

TAXACEAE

Podocarpus falcatus (Thunb.) R. Br. ex Mirb. 714 Sunridge Park, forest area, only known locality in valley

GRAMINEAE

Cymbopogon validus Stapf ex Burtt Davy 1200 Fern Glen, fynbos, common
Themeda triandra Forsk. 1199 Fern Glen, fynbos, common
Panicum deustum Thunb. 1311 Target Kloof area, near river, common
P. maximum Jacq. 978 Target Kloof area, near river, common
Digitaria eriantha Steud. 1312 Target Kloof area, near river, common
Setaria perennis Hack. 1183 Fern Glen, dry area of river bed, common
Stenotaphrum secundatum (Walt.) Kuntze 962 End of Alcock Road, Walmer, near river, common
Ehrharta calycina J. E. Sm. 1180 Fern Glen, dry area of river bed, common
Lagurus ovatus L. 1447 Below Fern Glen, in dry area of river bed, common
Cynodon dactylon (L.) Pers. All along river bed
Phragmites australis (Cav.) Trin. ex Steud. 1317 All along river bed
Eragrostis capensis (Thunb.) Trin. 1185 Fern Glen, dry area of river bed, common
E. curvula (Schrad.) Nees 1182 Fern Glen, Target Kloof area, near river, common
Briza maxima L. 1186 Fern Glen, dry area of river bed, common
B. minor L. 1184 Fern Glen, dry area of river bed, common
Lolium multiflorum Lam. 1453 Fairview, disturbed fynbos, common

CYPERACEAE

Cyperus textilis Thunb. 974 End of Alcock Road, Walmer, in river bed, common
Mariscus riparius Schrad. 1253 End of Janssens Avenue, Fern Glen, near river, only one plant seen
Ficinia deusta (Berg.) Levyns 1556 Fairview, fynbos, common
F. gracilis Schrad. 731 Sunridge Park, in wet fynbos areas
Tetraria eximia C.B.Cl. 1552 Fairview, restricted to one stand within a fynbos community

ARACEAE

Zantedeschia aethiopica (L.) Spreng. Target Kloof area, in river bed, fairly common

RESTIONACEAE

Elegia parviflora Kunth 1436 End of Janssens Avenue, Fern Glen, in damp fynbos area
E. vaginulata Mast. 1554 Fairview, fynbos, common
Thamnochortus glaber Pillans 701 Sunridge Park, in fynbos area, common

COMMELINACEAE

Commelina africana L. 1039 End of Mill Park Road, Mill Park, flowers yellow, forest margin
C. benghalensis L. 1035 End of Mill Park Road, Mill Park, flowers blue, forest margin

JUNCACEAE

Juncus (?) *oxycarpus* E. Mey. ex Kunth 1239 Fern Glen, in river bed

LILIACEAE

Wurmbea latifolia (Bak.) B. Nord. 875 Sunridge Park, fynbos area, uncommon
Bulbine caulescens L. 1017 End of Mill Park Road, Mill Park, on ridge
B. latifolia Roem. & Schult. 1157 Glen Hurd, in badly disturbed area

Trachyandra (?) sp. 873 Sunridge Park, fynbos area, fairly common
Kniphofia uvaria (L.) Hook. 1543 Sunridge Park, fynbos area, rare
Aloe africana Mill. Scattered along valley, in bush clumps
A. ferox Mill. Scattered along valley, in bush clumps
A. microcantha Haw. Sunridge Park, fynbos area, rare
A. pluridens Haw. Fern Glen, Fairview, in bush, common
Haworthia sp. 1319 Thomas Road, Walmer, on rocky outcrop, rare
Tulbaghia cepacea L.f. 1029 End of Mill Park Road, Mill Park, on ridge, common
Ornithogalum caudatum Jacq. 1158 Glen Hurd, in badly disturbed area, common
O. dubium Houtt. 834, 874, 1444 Sunridge Park, fynbos area, yellow flowers, uncommon
Veltheimia viridifolia Jacq. In bushy areas, all along valley, fairly common
Asparagus asparagoides (L.) Wight Target Kloof, forest
A. densiflorus (Kunth) Jessop 1540 Mill Park, forest margin
A. racemosus Willd. 1057 Target Kloof area, Glen Hurd, forest margin
A. stipulaceus Lam. 1558 Fairview, fynbos
A. suaveolens Burch. 1034 End of Mill Park Road, Mill Park, forest margin

HAEMODORACEAE

Wachendorfia paniculata L. 836 Sunridge Park, fynbos area, uncommon

AMARYLLIDACEAE

Haemanthus magnificus Herb. Target Kloof area, forest, rare
Brunsvigia orientalis (L.) Ait. ex Eckl. Sunridge Park, fynbos, rare
Cyrtanthus clavatus (L'Hérit.) R. A. Dyer 1551 Fairview, fynbos, rare
C. obliquus (L.f.) Ait. Fairview, fynbos, uncommon
Hypoxis sp. 1272 Fairview, fynbos, rare
Spiloxene trifurcillata (Nel) Fourc. 1038 End of Mill Park Road, Mill Park on ridge, fairly common

DIOSCOREACEAE

Dioscorea (?) *cotonifolia* Kunth 1318 Target Kloof area, forest, uncommon
D. sylvatica (Kunth) Eckl. 983 Target Kloof area, forest, uncommon

IRIDACEAE

Romulea longipes Schlechtd. 831 Sunridge Park, fynbos area, uncommon
Moraea stewartae N. E. Br. 712 Sunridge Park, fynbos area, uncommon
Bobartia orientalis J. B. Gillet 883 Sunridge Park, abundant in burnt fynbos areas
Aristea anceps Eckl. 1271 Fairview, fynbos, rare
A. pusilla (Thunb.) Ker-Gawl. Sunridge Park, fynbos area, rare
Geissorhiza rosea (Klatt) Fost. Sunridge Park, fynbos area, uncommon
Ixia lineata Ker-Gawl. 833 Sunridge Park, fynbos area, rare
I. orientalis L. Bol. 730 Sunridge Park, fynbos area, rare
Babiana patersoniae L. Bol. Fern Glen, abundant on flat fynbos areas
Gladiolus liliaceus Houtt. 835 Sunridge Park, Glen Hurd, fynbos areas
G. mutabilis G. J. Lewis 700 Sunridge Park, fynbos area, rare
G. permeabilis Delaroche subsp. *permeabilis* 1264 Fairview, fynbos, rare
Anapalina intermedia (Bak.) G. J. Lewis 1102 Mangold Park, fynbos area, rare
A. nervosa (Thunb.) G. J. Lewis 954 Sunridge Park, Mill Park, Fairview, fynbos areas, fairly common
Watsonia pillansii L. Bol. 953 All along valley in fynbos areas, common

ORCHIDACEAE

Holothrix lindleyana Reichb. f. 1160 Glen Hurd, in bush clump on rocky outcrop, rare
Bartholina lindleyana Reichb. f. 721 Sunridge Park, very localised, only in areas where it is very wet in winter and dry in summer, rare

Satyrium maculatum Burch. ex Lindl. 1275 Fairview, fynbos, rare
Schizodium rigidum Lindl. 1341 Target Kloof area, rare
Herschelia lugens (H. Bol.) Kraenzl. 993 Sunridge Park, fynbos area, rare
Disperis capensis (L.) Swartz 720 Sunridge Park in fynbos areas where it is very wet in winter and dry in summer, rare

MYRICACEAE

Myrica quercifolia L. 1229 Fern Glen, fynbos area, common
M. serrata Lam. Sunridge Park, fynbos area, uncommon

MORACEAE

Ficus burtt-davyi Hutch. 1049 Scattered along the valley on krantzes

PROTEACEAE

Protea neriifolia R. Br. 1114 All along river in fynbos areas
Leucospermum cuneiforme (Burm. f.) Rourke 774 Widespread in fynbos areas
Leucadendron salignum Berg. 703 Widespread in fynbos areas

LORANTHACEAE

Viscum capense L.f. 1203 Fern Glen, bush, fairly common
V. rotundifolium L.f. 451 Target Kloof area, forest, fairly common

SANTALACEAE

Colpoon compressum Berg. 976 Common all along valley in bushy areas
Rhoiacarpos capensis (Harv.) A.DC. 1187 Fern Glen, in bush clumps, uncommon
Thesium junceum Bernh. 1116 Fern Glen, fynbos area, uncommon
T. subnudum Sond. 776 Sunridge Park, fynbos area, uncommon

POLYGONACEAE

Rumex sagittatus Thunb. 1230 In river bed near William Moffett Express Way, common
Polygonum acuminatum Meisn. var. *capense* Meisn. 984 Target Kloof area, in river bed, common

CHENOPODIACEAE

Exomis microphylla (Thunb.) Aellen var. *axyrioides* (Fenzl et Moq.) Aellen 1463 All along valley in disturbed areas

PHYTOLACCACEAE

Phytolacca octandra L. 1201 Fern Glen, in bush clumps, uncommon

AIZOACEAE

Galenia pubescens (Eckl. & Zeyh.) Druce 1542 Mill Park, forest margin, uncommon
G. secunda (L.f.) Sond. 1548 Sunridge Park, fynbos, uncommon
Carpobrotus deliciosus (L. Bol.) L. Bol. Common in open areas
C. edulis (L.) N.E. Br. Common in open areas
Mesembryanthemum aitonis Jacq. 1220 Fern Glen, disturbed area in river bed
Ruschia rigida (Haw.) Schwant. 1298 Fairview near Frame's Drift
R. tenella (Haw.) Schwant. 987 Target Kloof area, near river, common
Delosperma lehmannii (Eckl. & Zeyh.) Schwant. 1238, 1538 Thomas Road, Walmer, on rocky outcrop, common
Drosanthemum sp. 1533 Below Mill Park, forest margin, common
Lampranthus productus N. E. Br. 988 Target Kloof area, near river, common

CARYOPHYLLACEAE
Pollichia campestris Ait. 448 Target Kloof area, forest, uncommon
Silene undulata Ait. 1241 Fern Glen, near river bed, uncommon

NYMPHAEACEAE
Nymphaea capensis Thunb. Target Kloof area, in pools, common

RANUNCULACEAE
Clematis brachiata Thunb. 326 End of Alcock Road, Walmer, near river bed, uncommon

MENISPERMACEAE
Antizoma capensis (L.f.) Diels 1058 Dodd's Farm, in bush clumps, uncommon

CRUCIFERAE
Heliophila sp. 1112 Mangold Park, fynbos, rare

CAPPARIDACEAE
Maerua cafra (DC.) Pax 1438 Fern Glen, in bush clump, uncommon

DROSERACEAE
Drosera cistiflora L. Sunridge Park, Fern Glen, in damp fynbos areas, common

CRASSULACEAE
Cotyledon salmiana V. Poelln. 1465 Walmer, Mill Park, Fern Glen, on rocky outcrops, common
Crassula cultrata L. 1293 Fairview near Frame's Drift, dry fynbos, common
C. lycopodioides Lam. 1007 End of Mill Park Road, forest margin, uncommon
C. marginalis Soland. 1159 Glen Hurd in badly disturbed area, common
C. perforata L. 1015 End of Mill Park Road, Mill Park, Fairview near Frame's Drift, rocky outcrops, common
C. rubricaulis Eckl. & Zeyh. 1323 Thomas Road, Walmer, on rocky outcrop, common
C. tetragona L. 1291 Fairview, near Frame's Drift, dry fynbos, common

SAXIFRAGACEAE
Montinia caryophyllacea Thunb. 735 Sunridge Park, fynbos area, very common

PITTOSPORACEAE
Pittosporum viridiflorum Sims 1098 Scattered all along valley, in forest areas

ROSACEAE
Rubus rigidus Smith 957 Common along river bed
Cliffortia ferruginea L.f. 1437 End of Janssens Avenue, Fern Glen, in damp fynbos area, uncommon
C. ilicifolia L. 704 Sunridge Park, fynbos area, common
C. odorata L.f. 510, 981 Target Kloof area, near river bed, common

LEGUMINOSAE
Acacia karroo Hayne 1274 Fairview, bush clumps, uncommon
Schotia afra (L.) Thunb. var. *afra* Dodd's Farm, bush clumps, uncommon
S. latifolia Jacq. 1109 Mangold Park, forest area, uncommon
Podalyria cuneifolia Vent. 1205 Fern Glen, Sunridge Park near Stella Londt Convalescent Home, fynbos, uncommon

Rafnia elliptica Thunb. 1263 Fairview, in very sandy soil, bush margin, uncommon
Lotononis azurea (Eckl. & Zeyh.) Benth. 1099 Mangold Park, Glen Hurd, fynbos areas, uncommon
Aspalathus chortophila Eckl. & Zeyh. subsp. *chortophila* 1030 Mill Park, Fern Glen, Fairview, fynbos, common
A. collina Eckl. & Zeyh. subsp. *collina* 702 Sunridge Park, fynbos area, common
A. hispida Thunb. subsp. *albiflora* (Eckl. & Zeyh.) R. Dahlgr. 1446 Fern Glen, dry area of river bed, fairly common
A. rubens Thunb. 1231 Fairview, very dry northern aspect, fairly common
A. setacea Eckl. & Zeyh. 1296 Fairview near Frame's Drift, disturbed fynbos, uncommon
A. spinosa L. subsp. *spinosa* 1246 Fern Glen, fynbos, uncommon
Crotalaria capensis Jacq. 970 Target Kloof area, Fern Glen, edge of river bed, common
Indigofera sulcata DC. 777 Sunridge Park, fynbos area, common
Rhynchosia caribaea (Jacq.) DC. 443 Target Kloof area, forest, fairly common
Dipogon lignosus (L) Verdc. 1217 Fern Glen, southern aspect, in bush, common

GERANIACEAE

Pelargonium alchemilloides (L.) L'Hérit. ex Ait. 1245 Fairview, near river, common
P. longifolium Jacq. 1451 Glen Hurd, fynbos, rare
P. peltatum (L.) L'Hérit. 1224 Fern Glen, in bush clumps, common
P. populifolium Eckl. & Zeyh. 1228 Fern Glen, near river, common
P. reniforme Curtis 1244 Fairview, fynbos, common

OXALIDACEAE

Oxalis smithiana Eckl. & Zeyh. 1037 End of Mill Park Road, Mill Park, forest margin, fairly common

ZYGOPHYLLACEAE

Zygophyllum fulvum L. 1068 Dodd's Farm, uncommon

RUTACEAE

Fagara capensis Thunb. 1178 Fern Glen, bush, uncommon
F. davyi Verdoorn 1067 Dodd's Farm, bush, uncommon
Agathosma gonaquensis Eckl. & Zeyh. 1028 End of Mill Park Road, Mill Park, forest margin, common
A. ovata (Thunb.) Pillans 1076 Target Kloof area, Mangold Park, forest margin, common
Vepris undulata (Thunb.) Verdoorn ex C.A. Sm. Dodd's Farm, forest, uncommon

MELIACEAE

Ekebergia capensis Sparrm. 1101 Fairly common along valley in forest areas

POLYGALACEAE

Polygala ericaefolia DC. 778 Sunridge Park, fynbos area, common
P. fruticosa Berg. 1176 Fern Glen, Fairview, fynbos, fairly common
Muraltia alopecuroides (L.) DC. 780 Sunridge Park, fynbos area, uncommon
Nylandtia spinosa (L.) Dumort. 447 End of Alcock Road, Walmer and Fern Glen, common on dry areas of river bed

EUPHORBIACEAE

Clutia brevifolia Sond. 710 Sunridge Park, fynbos area, common
C. rubricaulis Eckl. ex Sond. 715 Fairview, fynbos, common
Euphorbia clava Jacq. Fairview, dry northern aspect, rare
E. polygona Haw. 1320 Thomas Road, Walmer, rocky outcrop, rare
E. silenifolia (Haw.) Sweet 1614 Fern Glen, fynbos, rare

ANACARDIACEAE

Rhus incisa L.f. var. *obovata* (Sond.) Schoenl. 1188 Fern Glen, bush, fairly common
R. laevigata L. (= *R. mucronata* Thunb.) 1287 Fairview near Frame's Drift, uncommon
R. longispina Eckl. & Zeyh. 985 Target Kloof area, forest margin, fairly common
R. lucida L. 1062 Dodd's Farm, bush clump, uncommon
R. lucida var. *scoparia* (Eckl. & Zeyh.) Schoenl. 1443 Sunridge Park, bush clump, uncommon
R. macowanii Schoenl. 958 Target Kloof area, forest margin, fairly common
R. rosmarinifolia Vahl 736 Sunridge Park, fynbos area, common
R. schlechteri Diels 1142 Glen Hurd, Fern Glen, bush clumps, common
R. tomentosa L. 1108 Mangold Park, Glen Hurd, Fairview, bush clumps, very common
R. undulata Jacq. var. *undulata* 1107 Mangold Park, Glen Hurd, bush clumps, common

CELASTRACEAE

Maytenus acuminata (L.f.) Loes. 1027 Mill Park, forest areas, uncommon
M. heterophylla (Eckl. & Zeyh.) N. K. B. Robson 990 Target Kloof area, Fern Glen, forest, fairly common
M. nemorosa (Eckl. & Zeyh.) Marais 991 Target Kloof area, forest, uncommon
Putterlickia pyracantha (L.) Szyszyl. 1050 Target Kloof area, Fern Glen, bush clump, uncommon
Pterocelastrus tricuspidatus (Lam.) Sond. 327 Common all along valley in forest areas and bush clumps
Cassine aethiopica Thunb. 1055 Target Kloof area, forest, fairly common
C. maritima (H. Bol.) L. Bol. 1059 End of Thomas Road, Walmer, on krantz, uncommon
C. peragua L. 1065 Dodd's Farm, forest, uncommon
C. tetragona (L.f.) Loes. 1056 Target Kloof area, Fern Glen, forest, fairly common

ICACINACEAE

Apodytes dimidiata E. Mey. ex Arn. 1053 Dodd's Farm, forest, uncommon

SAPINDACEAE

Allophylus decipiens (Sond.) Radlk. 965 Scattered along valley in bush clumps
Smelophyllum capense (Sond.) Radlk. 1072 Common along valley on krantzes
Hippobromus pauciflorus (L.f.) Radlk. 1115 Very common all along valley in forest areas and bush clumps

RHAMNACEAE

Scutia myrtina (Burm. f.) Kurz 961 Common all along valley
Phylica gnidioides Eckl. & Zeyh. 1066 Dodd's Farm, fynbos area, fairly common
P. willdenowiana Eckl. & Zeyh. 1439 Glen Hurd, fynbos, fairly common

VITACEAE

Rhoicissus tridentata (L.f.) Wild & Drummond 1196 Fern Glen, in bush clumps, fairly common

TILIACEAE

Grewia occidentalis L. 992 Fairly common all along valley in bush clumps

MALVACEAE

Abutilon sonneratianum (Cav.) Sweet 479 Target Kloof area, near river, uncommon
Anisodontea scabrosa (L.) Bates 444 Target Kloof area, near river, uncommon
Hibiscus aethiopicus L. 629 Sunridge Park, fynbos, uncommon
H. aethiopicus L. var. *diversifolius* Harv. 1550 Fairview, burnt fynbos, common
H. trionum L. 328 Target Kloof area, Fern Glen, near river bed, uncommon

STERCULIACEAE

Hermannia althaeoides Link 477 Target Kloof area, near river bed, uncommon
H. hyssopifolia L. 476 Sunridge Park, near river bed, fairly common
H. sulcata Harv. 1105 Mangold Park, fynbos, uncommon
H. velutina DC. 445 Target Kloof area, near river bed, fairly common

OCHNACEAE

Ochna arborea Burch. ex DC. 516 Target Kloof area, Fairview, forest and bush clumps, uncommon

GUTTIFERAE

Hypericum (?) *aethiopicum* Thunb. 1248 Fern Glen, fynbos, rare

OLINIACEAE

Olinia ventosa (L.) Cufod. 1036 Common all along the valley in forest areas

THYMELAEACEAE

Gnidia styphelioides Meisn. 734 Sunridge Park, fynbos area, common
Struthiola argentea Lehm. 1103 Mangold Park, fynbos area, uncommon
S. macowanii C.H. Wr. 706 Sunridge Park, fynbos area, fairly common
S. parviflora Bartl. ex Meisn. 779 Sunridge Park, fynbos area, uncommon
Passerina vulgaris Thoday 1197 Fern Glen, bush clumps, fairly common

MYRTACEAE

Eugenia zeyheri Harv. 1435 Sunridge Park, forest area, uncommon

ARALIACEAE

Cussonia spicata Thunb. 1151 Glen Hurd, forest, rare, one single plant seen
C. thyrsiflora Thunb. 1155 Common in bushy areas

UMBELLIFERAE

Centella coriacea Nannfd. 1289 Fairview, near Frame's Drift, in river bed
Heteromorpha arborescens (Spreng.) Cham. & Schlechtd. 966 Target Kloof area, near river bed, uncommon
Annesorrhiza macrocarpa Eckl. & Zeyh. 1295 Fairview, near Frame's Drift, rare

ERICACEAE

Erica cerinthoides L. 711 Very common in burnt fynbos areas
E. decipiens Spreng.f. 1288 Fairview near Frame's Drift, fynbos, uncommon
E. glandulosa Thunb. 1255 Fern Glen, fynbos area, uncommon
E. pectinifolia Salisb. 1546 Sunridge Park, fynbos area, rare
E. simulans Dulfer 699 Sunridge Park, fynbos area, fairly common

MYRSINACEAE

Rapanea gilliana (Sond.) Mez 1232 Fern Glen, forest margin, uncommon
R. melanophloeos (L.) Mez 1025 Mill Park, Fern Glen, forest areas, uncommon

SAPOTACEAE

Sideroxylon inerme L. 1433 All along valley in forest areas, common

EBENACEAE

Euclea polyandra (L.f.) E. Mey. ex Hiern 1192 Fern Glen, fynbos, common
E. racemosa Murr. (?) forma 1100 Mangold Park, bush clump, uncommon

Euclea racemosa Murr. or *E. schimperi* (A.DC.) Dandy 973 Target Kloof area, forest margin
E. undulata Thunb. var. *undulata* 1221 Fern Glen, bush clumps, common
Diospyros dichrophylla (Gand.) de Winter 960 Target Kloof, common in bush clumps
D. scabrida (Harv. ex Hiern) de Winter var. *cordata* (E. Mey. ex A.DC.) de Winter 1233 Fairview, very dry northern aspect, plants very stunted, uncommon

OLEACEAE

Olea africana Mill. Forest areas, uncommon
O. capensis L. subsp. *capensis* 1143 Common along valley in forest areas
O. exasperata Jacq. 1156 Glen Hurd, in disturbed area
Jasminum angulare Vahl 1278 Fairview, bush clumps, common

SALVADORACEAE

Azima tetracantha Lam. Fern Glen, in bush clump, uncommon

GENTIANACEAE

Chironia baccifera L. 1052 Dodd's Farm, fynbos, fairly common
C. penduncularis Lindl. 1214 Fern Glen, fynbos, uncommon
C. tetragona L.f. 1268 Fairview, fynbos, uncommon

APOCYNACEAE

Carissa bispinosa (L.) Desf. ex Brenan var. *bispinosa* 471 Target Kloof area, Fern Glen, forest, fairly common

ASCLEPIADACEAE

Microloma tenuifolium K. Schum. 719 Sunridge Park, fynbos area, fairly common
Cynanchum obtusifolium L.f. 450 Target Kloof area, forest, common
Sarcostemma viminale (L.) R. Br. 1191 Fern Glen, in bush clumps, common
Secamone alpini Schultes 1541 Below Mill Park, forest margin, fairly common

CONVOLVULACEAE

Cuscuta cassytoides Nees ex Engelm. Sunridge Park, fynbos area, common

BORAGINACEAE

Ehretia rigida (Thunb.) Druce 1208 Fern Glen, stunted, in bush clump, uncommon
Lobostemon trigonus Buek 775 Common in fynbos areas, flowers blue, common

LABIATAE

Leonotis sp. 1266 Fairview, near river bed, uncommon
Salvia aurea L. 1173 Fern Glen, near river bed, fairly common

SOLANACEAE

Lycium sp. 1441 Sunridge Park, bush clump, uncommon
Solanum tomentosum L. 1075 Target Kloof area, near river bed, uncommon

SCROPHULARIACEAE

Nemesia affinis Benth. 442 End of Alcock Road, Walmer, disturbed area of river bed, uncommon
Halleria lucida L. 1250 Fern Glen, stunted, bush, uncommon
Manulea obovata Benth. 472 End of Alcock Road, Walmer on disturbed area of river bed, common
M. parviflora Benth. 1265 Fairview, disturbed area

Sutera argentea (L.f.) Hiern 1211 Fern Glen, white flowers, fynbos, uncommon
Selago glomerata Thunb. 1032 Mill Park, fynbos, common
Walafrida nitida E. Mey. 1033 Mill Park, fynbos, common
Graderia scabra (L.f.) Benth. 1547 Common in burnt fynbos areas
Harveya purpurea Harv. 882 Sunridge Park, pink flowers, fynbos, uncommon
Hyobanche sanguinea L. 1218 Fern Glen, Fairview, fynbos, uncommon

BIGNONIACEAE

Tecomaria capensis (Thunb.) Spach 986 Target Kloof area, garden escape?

ACANTHACEAE

Blepharis procumbens (L.f.) Pers. 1269 Fairview on very dry slope, blue flowers, rare
Hypoestes aristata R. Br. 1078 End of Alcock Road, Walmer, near river bed, common

RUBIACEAE

Canthium spinosum (Klotzsch) Kuntze 1179 Fern Glen, bush clump, uncommon
C. ventosum (L.) S. Moore 716 Wide spread in forest areas
Anthospermum aethiopicum L. 1148 Glen Hurd, Sunridge Park, fynbos areas, common

DIPSACACEAE

Scabiosa columbaria L. 1219 Fern Glen, Sunridge Park, fynbos areas, uncommon

CUCURBITACEAE

Zehneria scabra (L.f.) Sond. 1209 Fern Glen, bush clump, uncommon

CAMPANULACEAE

Roella spicata L. 955, 1031 Sunridge Park, Mill Park, fynbos, uncommon
Prismatocarpus campanuloides (L.f.) Sond. 1557 Fairview, fynbos, uncommon
Wahlenbergia undulata A.DC. 1286 Fairview, near Frame's Drift, fynbos, uncommon
Lightfootia divaricata Buek var. *debilis* (Sond.) Adamson 1213 Fern Glen, fynbos, fairly common
Cyphia sylvatica Eckl. 1021 Mill Park, fynbos, uncommon
Lobelia erinus L. 1226 Fern Glen, southern aspect, fairly common
L. tomentosa L. 732 Sunridge Park, fynbos area, common

COMPOSITAE

Corymbium africanum L. 885 Sunridge Park, fynbos area, uncommon
C. glabrum L. 1442 Sunridge Park, fynbos area, uncommon
Pteronia baccharoides Less. 707 Sunridge Park, fynbos area, common
Felicia erigeroides DC. 1070 Target Kloof area, near river, uncommon
Conyza ivifolia (L.) Less. 980 Target Kloof area, in river bed, common
Tarchonanthus camphoratus L. 971 Widespread along valley in forest areas
Helichrysum anomalum Less. 705 Sunridge Park, fynbos area, common
H. argenteum Thunb. 709 Sunridge Park, fynbos area, common
H. felinum (Thunb.) Less. 1204 Fern Glen, fynbos, fairly common
H. metalasioides DC. 1445 Fern Glen, dry area of river bed, fairly common
H. squamosum Thunb. 1545 Sunridge Park, fynbos area, rare
H. teretifolium (L.) D.Don 1222 Fairview, fynbos, fairly common
Disparago ericoides Gaertn. 708 Sunridge Park, fynbos area, common
Metalasia muricata (L.) D.Don 1553 Fynbos areas, common
Relhania trinervis Thunb. 886 Sunridge Park, fynbos area, fairly common
Athrixia crinata (L.) Druce 733 Sunridge Park, fynbos area, uncommon
Printzia bergii Cass. 1147 Glen Hurd, Fern Glen, badly disturbed areas, fairly common
Eriocephalus africanus L. 1063 Dodd's farm, very common in drier habitats

Athanasia dentata L. 884, 1202 Sunridge Park, Fern Glen, fynbos, common
Cineraria sp. 1216 Fern Glen, fynbos, fairly common
Senecio ilicifolius Thunb. 1223 Fern Glen, very abundant in disturbed areas
S. reclinatus L.f. 1252 Fern Glen, fynbos, uncommon
S. tamoides DC. 1457 Below Mill Park, in forest, garden escape?
Eurypos algoënsis DC. 1064 Dodd's Farm, fynbos, fairly common
E. munitus (L.f.) B. Nordenstam 1024 Mill Park, fynbos, fairly common
Othonna carnosa Less. 1016 Mill Park, on ridge, fairly common
Osteospermum junceum Berg. 1227 In river bed near William Moffett Express Way
Chrysanthemoides monilifera (L.) Norl. 1097 Common throughout valley
Arctotheca calendula (L.) Levyns 1172 Fern Glen in river bed, common
Gazania linearis (Thunb.) Druce 628 Sunridge Park, fynbos, fairly common
Berkheya angustifolia (Houtt.) Merrill 1113 Mangold Park, Glen Hurd, disturbed area
B. heterophylla (Thunb.) O. Hoffm. var. *radiata* (DC.) Roessl. 977 Target Kloof area near river bed, fairly common
Sonchus dregeanus DC. 1225 Fern Glen, near river bed, common

ALIEN SPECIES

PINACEAE

Pinus halepensis Mill. 1026 Occasional trees scattered along valley

GRAMINEAE

Pennisetum clandestinum Hochst. ex Chiov. All along valley escaping from gardens
Avena fatua L. 1243 Fairview, disturbed fynbos, common
Bromus willdenowii Kunth 1181 Fern Glen, dry area of river bed, common

SALICACEAE

Populus sp. 1432 Very abundant in kloof between Sunridge Park and Fern Glen and spreading down river more or less to an area opposite Janssens Avenue

PROTEACEAE

Hakea suaveolens R. Br. 1431 Worst infestations in fynbos areas west of Dodd's Farm on northern bank

FUMARIACEAE

Fumaria muralis Sond. ex Koch 781 Disturbed fynbos areas

LEGUMINOSAE

Albizia lophantha (Willd.) Benth. 1434 In kloof between Sunridge Park and Fern Glen
Acacia cyclops Cunn. 1340 Scattered along valley
A. decurrens (Wendl.) Willd. 1337 Occasional trees scattered along valley, more abundant near Frame's Drift
A. longifolia (Andr.) Willd. 713 Very abundant especially Sunridge Park area forming dense stands in fynbos
A. saligna (Labill.) Wendl. 1338 All along valley, in fynbos, dense stands east of William Moffett Express Way, on northern bank
Sesbania punicea (Cav.) Benth. 1450 All along river bed, worst infestations east of Dodd's Farm, spreading fast

EUPHORBIACEAE

Ricinus communis L. Isolated plants along valley

CACTACEAE

Opuntia sp. Isolated plants

GUTTIFERAE

Hypericum sp. 1458 Below Mill Park, isolated plants on forest margin

MYRTACEAE

Eucalyptus lehmanii (Preiss ex Schau.) Benth. 1454 Occasional trees along valley
Eucalyptus sp. Very abundant near Frame's Drift and in river bed below Glen Hurd
Leptospermum laevigatum F. Muell. 1174 Scattered along valley

UMBELLIFERAE

Foeniculum vulgare Mill. 972 All along valley

SOLANACEAE

Cestrum laevigatum Schltr. 1448 Isolated plants along valley

PLANTAGINACEAE

Plantago lanceolata L. 1254 In disturbed areas

COMPOSITAE

Xanthium strumarium L. 1316 End of Alcock Road, Walmer, dry areas of river bed

ACKNOWLEDGEMENTS

I wish to thank the staff of the Compton Herbarium, Kirstenbosch for identifying the specimens, Mrs Estelle Brink, B.R.U., Grahamstown for checking the author names as far as possible, Mrs Gwen Skinner for useful information and for accompanying me into the area on most of my visits and Mrs Felicity Kapp for technical assistance.

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PHILLIPS, E. P., 1951. The genera of South African Flowering Plants. *Mem. bot. Surv. S.Afr.* **25:** 1–923.

Jl S. Afr. Bot. 43(2): 161–162 (1977)

BOOK REVIEWS

SOUTH AFRICAN PLACE NAMES, by O. A. Leistner and J. W. Morris. *Annals of the Cape Provincial Museums* vol. 12: 1–565, Oct. 1976. (Limp Cover) R10,00, obtainable from Director, Albany Museum, Grahamstown 6140.

Ten years have elapsed since Edwards and Jessop published their proposed replacement of magisterial districts with a quarter degree latitude—longitude grid as a more stable system for citing botanical records in South Africa. Through the efforts of the Botanical Research Institute, the new system very rapidly gained acceptance. Inevitably, the citation of records according to the quarter degree grid system imposed greater discipline on taxonomists as they were forced to check the accuracy of their records more closely than before. It was a tedious time-consuming operation. To simplify matters, the Botanical Research Institute produced a few computer printed indexes of localities and place names with their quarter degree equivalents. These precious indexes were much used and highly prized by those establishments favoured with a copy. Happily, the list is now available to all. One can only marvel that it was possible to assemble a team of map-scanners who could endure the mental prostitution required to compile so prodigious a tome covering place names in South Africa, Botswana and South West Africa. It is an heroic achievement.

There are errors. For instance, the *Karoo Botanic Garden* is given under 3320 BA Montagu, whereas it should be 3319 CB Worcester.

There are omissions—*Signal Hill* above Cape Town, is curiously absent. There are also anomalies. One imagines for example, that residents of so inconsequential a place as *Who Can Tell* (3022 BA Carnarvon) must be flushed with pride to find that this happy little haven is listed while that infinitely more important but equally sun-baked habitation, *Hotazel*, (2622 CB Tsabong) has been left out in the cold! Until studying this publication the reviewer would have staked his life on the assumption that *Rietfontein* is the commonest place name in South Africa. But, *Rietfontein* (61 entries) is actually way behind, with *Spitzkop* (112 entries) leading the field!

Despite these comments, which should not be taken too seriously, the only major deficiency is the absence of farm names and land grants such as appear on the 1: 250 000 Topo—Cadastral series of maps. These most useful maps were apparently not consulted. Of course, the compilers are well aware of this and stress that the work should be looked upon as an aid rather than an encyclopedia. Refinements and corrections will surely find their way into future editions but it will be very much up to the users to help fill in the gaps.

South African Place Names is a godsend; all who use it should offer up prayers of thankfulness for the drudgery it will take out of their lives. Surely, it will be at the righthand of all monographers of the South African flora and is destined to become one of the most thumbed books in our herbaria. Buy it now!

J. P. ROURKE

POLLEN: BIOLOGY, BIOCHEMISTRY, MANAGEMENT, by R. G. Stanley and H. F. Linskens, with pp x × 307, 64 figures and 66 tables. Berlin-Heidelberg-New York: Springer-Verlag. Cloth DM 59, 80; US $24,40.

Although several books on pollen (mainly on palynology) and pollination mechanisms are available, they contain little if anything on the physiology and chemical composition of pollen. This aspect of pollen research is rapidly developing and is yielding valuable information of a fundamental or applied nature. Stanley (Univ. of Florida, U.S.A.) and

Linskens (Univ. of Nijmegen, Netherlands), who have contributed significantly to this field, have by the writing of this book successfully filled the need, in part, for a comprehensive authoritative work on pollen management and physiology. The authors planned to write a second volume on such aspects of pollen physiology as incompatibility reactions, stigma responses, population effects, tropisms, metabolic and cytological changes during growth and the influence of different chemicals and treatments on the *in vitro* and *in vivo* growth of pollen – topics which are not covered by the book presently under review. It is hoped that despite the untimely death of Stanley, the proposed book will still appear in order to provide the interested reader with a complete coverage of the physiology of pollen.

The first three chapters of the book concerns the "Biology" of pollen. After a brief but valuable discussion of the terminology at present in use by different authors, attention is paid to the development of pollen, its dehiscence, size, quantity produced by various species and the distribution of pollen.

The second section of the book, under the heading: "Management" deals with the collection and uses of pollen, methods of storing pollen, factors that influence the viability of pollen, viability tests and the nutritive role of pollen. In this part of the book more attention should have been devoted to the use by man of honey bees for the collection of pollen.

In the final section, entitled: "Biochemistry", separate chapters are devoted to (a) the general chemical composition of pollen with special reference to its mineral constituents, (b) carbohydrates, especially those occurring in pollen cell walls, (c) organic acids, lipids and sterols, (d) amino acids and proteins, (e) nucleic acids, (f) enzymes and cofactors, (g) pigments, and (h) growth substances. The interesting allergic responses of humans to pollen is also discussed in a chapter entitled "Pollinosis".

The book is relatively free of errors and has an attractive appearance. It is written in a concise but lucid style. One of the major attributes of the book is the very considerable amount of data which it contains. The bibliography contains no less than 1 400 references which are listed alphabetically but unfortunately does not include the titles of the publications concerned. This extensive bibliography together with a comprehensive subject index makes the book a standard reference work which no worker in the field of pollen physiology could do without. It will probably be used mainly by research workers, lecturers and honours students due to its specialized nature and high cost.

N. GROBBELAAR

INSTRUCTIONS TO CONTRIBUTORS TO THE JOURNAL OF SOUTH AFRICAN BOTANY

This Journal provides a medium for the publication of the results of botanical research primarily on the flora of Southern Africa, whether systematic, morphological, ecological or otherwise and whether carried out in South Africa or elsewhere. Papers on botanical subjects of special interest and application in South Africa may be included.

Contributions must be original and should not be translations of previously published papers.

Papers must be submitted in final, corrected form. They are accepted for publication on the recommendation of the Editorial Committee.

Authors may be charged expenses for corrections if alterations are excessive.

COPY

Papers should be type-written, double spaced throughout on one side of the paper and with margins of at least 30 mm. Footnotes and elaborate tables should be avoided. Latin binomials should be underlined once to indicate italics. All other marking of copy should be left to the Editor. The original, plus at least one carbon copy, must be submitted.

GENERAL LAY-OUT

Each paper should be headed with a concise informative **title** in capitals with the author's name below. This should be followed by the name of the institution, where the work was carried out, underlined and placed within brackets.

A concise written **abstract** in English and Afrikaans, of not more than 200 words, should precede the text.

The subject matter should be divided into sections under short appropriate **headings** such as: INTRODUCTION, MATERIAL AND METHODS, RESULTS, DISCUSSION, CONCLUSION, ACKNOWLEDGMENTS, etc.

Tables and **illustrations** should be on separate sheets. **Figures** and **graphs** should be in Indian ink on white card or Bristol board. Lettering for figures can be inserted by the printers in which case authors should indicate the desired lettering on the original figure lightly in pencil. The maximum dimensions available for figures are 180 × 120 mm. Line drawings for blocks should be at least twice the size they will be when reduced for publication. All figures should be supplied with a scale. The most suitable method of indicating magnification is a scale line (in SI metric units) incorporated in the figure. Photographs for half-tone reproductions should be on glossy paper, clearly marked on the reverse side (in pencil) to indicate the top. Line drawings and half-tone illustrations are termed figures and should be numbered consecutively. Captions for figures should be typed on a separate sheet of paper.

METRICATION

Authors must use the international (SI) metric system for all measurements, e.g. linear units are to be expressed in metres and millimetres. The use of centimetres is to be avoided. (Metrication pamphlets are obtainable from the South African Bureau of Standards, Private Bag X191, Pretoria, 0001).

When a quotation is incorporated into the text, as in the instance of a locality citation in a taxonomic paper, the original units must be retained as they are of historical and archival importance.

TAXONOMIC PAPERS

Authors must adhere to the International Rules of Botanical Nomenclature. **Abbreviations** and **herbaria** must be cited in accordance with the most recent edition of Index Herbariorum,

Pt 1 (The Herbaria of the World, 5th ed., 1964). When **new species** are described, the exact location of type material must be indicated. When proposing **new combinations** the full citation of the basionym is required. **Indented keys** with numbered couplets are preferred when dealing with a small number of taxa. **Bracket keys** should be used when dealing with a large number of taxa. When citing **synonyms** they should be arranged chronologically into groups of nomenclatural synonyms and these should be arranged chronologically by basionyms. Whenever possible, the types of the basionyms should be cited, e.g.:

> **Bequaertiodendron magalismontanum** (Sond.) Heine & J. H. Hemsley in Kew Bull. **1960:** 307 (1960).
> *Chrysophyllum magalismontanum* Sond. in Linnaea **23:** 72 (1850): Type: Magaliesberg, *Zeyher 1849* (S, holo; BOL!, SAM!).
> *Zeyherella magalismontana* (Sond.) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105:** 37 (1958).
> *Pouteria magalismontana* (Sond.) A. Meeuse in Bothalia **7:** 335 (1960).
> *Chrysophyllum argyrophyllum* Hiern, Cat. Afr. Pl. Welw. **3:** 641 (1898). Syntypes: Angola, *Welwitsch 4827, 4828, 4829* (BM!).
> *Boivinella argyrophylla* (Hiern) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105:** 37 (1958).
> *Chrysophyllum wilmsii* Engl., Mon. Sapot. Afr.: 47 t. 16 (1904). Type: Transvaal, *Wilms 1812* (B†, holo.; K!).
> *Boivinella wilmsii* (Engl.) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105:** 37 (1958).

CITATION OF SPECIMENS

In the interests of uniformity contributors are requested to follow the recommendations of Leistner and Morris (*Ann. Cape prov. Mus.* **12:** 1976) by citing specimens according to the one degree grid system. Distribution data are given separately for each province and are arranged in the following sequences: South West Africa, Botswana, Transvaal, Orange Free State, Swaziland, Natal, Lesotho, Cape. Within each province degree squares are listed in numerical sequence, i.e., from west to east and from north to south. Whenever possible locality records should be given to within a quarter degree square. The collectors' names and numbers are underlined *(printed in italics)* to avoid confusion with the numbers of the degree squares, e.g.: NATAL-2829 (Harrismith): Cathedral Peak Forest Station (-CC), *Killick B127* (PRE); . . . CAPE-3418 (Simonstown): Hottentots Holland mountains, Somerset Sneeukop (-BB), Nov., *Stokoe s.n.* sub. SAM *56390* (SAM)

REFERENCES

These should be given in the text as follows: Jones (1968) or (Jones, 1968) or, where reference to a specific page is required, Jones (1968: 57) or (Jones, 1968: 57). **Literature cited** should be arranged alphabetically by surnames, chronologically within each name, with suffixes a, b, etc., to the year for more than one paper by the same author in that year. Titles of **periodicals** must be abbreviated according to the *World List of Scientific Periodicals*, 4th ed., London: Butterworth or when unable to trace the title in this list (as will be the case in taxonomic papers where abbrevations of 18th and 19th century periodicals are required) the abbreviations given in *Botanico-Periodicum-Huntianum,* Pittsburgh: Hunt Botanical Library, 1968, should be followed. Periodical titles should be underlined once (for italics). If an author is unable to determine the correct abbreviation of a journal title he is advised to type it out in full and leave its abbreviation to the Editor. Titles of **books** should be underlined and given in full, together with the place of publication, name of the publisher and an indication of the edition if other than the first; e.g.:

> Davis, P. H. and Heywood, V. H., 1963. *Principles of Angiosperm Taxonomy*. Edinburgh and London: Oliver and Boyd.
> Riley, H. P., 1960. Chromosome numbers in the genus *Haworthia. Jl S. Afr. Bot.* **26:** 139–148.

Jl S. Afr. Bot. 43 (3): 163–185 (1977)

THE ARTICULATED CORALLINACEAE (RHODOPHYTA) OF SOUTH AFRICA: 1. *CHEILOSPORUM* (DECAISNE) ZANARDINI

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ABSTRACT

In the first part of this paper *Cheilosporum*, one of the several genera of articulated corallines occurring in South Africa, is examined for the morphological features which have most relevance to the systematics of the genus. Reproductive structures in particular give strong indication that *Cheilosporum* is more closely related to *Jania* and *Haliptylon* than to *Corallina, Arthrocardia* and other genera in the subfamily Corallinoideae. Relatively few tetrasporangia develop within a conceptacle, male conceptacles have a characteristic structure that has been seen before only in *Jania* and *Haliptylon*, and the carposporangial conceptacles similarly are like those in these two genera. In the second part of the paper, the taxonomy of the genus is treated. On the basis of examination of hundred of collections, it appears most natural to consider *Cheilosporum* as represented in South Africa by three species: *C. cultratum, C. proliferum,* and *C. sagittatum. Cheilosporum cultratum* includes two subspecies: *C. cultratum* ssp. *cultratum* and *C. cultratum* ssp. *multifidum* Kützing, comb. nov.

UITTREKSEL

DIE GEARTIKULEERDE CORALLINACEAE (RHODOPHYTA) VAN SUID-AFRIKA: 1. *CHEILOSPORUM* (DECAISNE) ZANARDINI

In die eerste gedeelte van die artikel word *Cheilosporum*, een van verskeie genera met geartikuleerde korralloïede wat in Suid-Afrika voorkom, ondersoek vir die morfologiese kenmerke wat die meeste betrekking op die systematiek van die geslag het. Voorplantingstrukture gee die beste aanduiding dat *Cheilosporum* nader verwant is aan *Jania* en *Haliptylon* as aan *Corallina, Arthrocardia* en ander genera in die subfamilie Corallinoideae. Relatief min tetrasporangia ontwikkel binne 'n instulping, manlike instulpings het 'n kenmerkende struktuur wat voorheen net in *Jania* en *Haliptylon* gesien is en die karposporangiale instulpings is ook soos die van die gemelde twee genera. In die tweede gedeelte van die artikel word die taksonomie van die genus behandel. Nadat honderde versamelings ondersoek is lyk dit logies dat *Cheilosporum* in Suid-Afrika verteenwoordig word deur drie soorte: *C. cultratum, C. proliferum* en *C. sagittatum. Cheilosporum cultratum* sluit twee subgenera in: *C. cultratum* ssp. *cultratum* en *C. cultratum* ssp. *multifidum* Kützing, comb. nov.

INTRODUCTION

The present study reveals salient structural and reproductive features of *Cheilosporum* and provides means for distinguishing the three species of the genus considered to occur in South Africa. *Cheilosporum* is one of six genera of articulated corallines present in this part of the world; the others are *Amphiroa, Arthrocardia, Corallina, Haliptylon* and *Jania*. These genera belong in the Corallinaceae subfamily Corallinoideae, except *Amphiroa* which is included in the

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subfamily Amphiroideae of the same family. The structure, reproduction and systematics of these genera will be treated in subsequent papers.

As currently understood, *Cheilosporum* is a clearly demarcated genus (Johansen, 1969) that appears to bear a closer alliance to *Jania* and *Haliptylon* than to *Corallina* (Johansen, 1970). This possibility needs to be examined, however, because the genus is poorly known, both as to taxonomically important features and as to component species. The study of the species inhabiting South African waters reveals that, in spite of differences in intergenicular shape and conceptacle positions, *Cheilosporum* does indeed belong to the *Jania*/*Haliptylon* alliance. The results of this study also reveal a close anatomical similarity of the South African taxa to *C. jungermannioides* Ruprecht in Areschoug as revealed by Segawa (1941) in the only other detailed study of *Cheilosporum.*

Cheilosporum is represented by three species in the region extending from Mozambique to western South Africa: *C. cultratum* (Harvey) J. Areschoug, *C. proliferum* (Lamouroux) DeToni and *C. sagittatum* (Lamouroux) J. Areschoug. Furthermore, *C. cultratum* includes two subspecies, *C. cultratum* ssp. *cultratum* and *C. cultratum* ssp. *multifidum* (Kützing) comb. nov. (The new combination is formally made later in the text.) The names *Amphiroa cultrata* var. *pectinata* Kützing (1858), *Amphiroa stangeri* Harvey (1847), *Amphiroa flabellata* Harvey (1847), *Amphiroa lamourouxiana* Decaisne (1842b) and *Cheilosporum sagittatum* f. *minor* DeToni (1905) are treated as synonomous with one or the other of the three species which I recognize as occurring in South Africa.

In addition to presenting taxonomic conclusions, another goal of the present paper is to reveal the main anatomical features of the genus. This is based mostly on *C. cultratum*, a common species in South Africa available in all reproductive states.

This paper is the first in a series dealing with the articulated corallines in South Africa. They are based on studies begun in 1967, when I collected extensively in that country. Particularly along the eastern and southern shore of South Africa, articulated corallines often are a common component of shallow waters (Seagrief, 1967), sometimes covering rock surfaces almost to the exclusion of non-corallinaceous algae. In my estimation, this region of Africa rivals or matches central California, parts of Japan and possibly southern Australia (Womersley, Ducker, pers. comm.) in density of corallines and species diversity (see Johansen, 1974).

In articulated corallines, the erect, jointed parts, the fronds, are attached to substrata by holdfasts. The calcified segments are called intergenicula; the uncalcified nodes are genicula.

HISTORY

When *Cheilosporum* was first created as a section of the genus *Amphiroa* (Decaisne, 1942b) based on *Corallina sagittata* Lamouroux (1824) from Mauritius, it was considered as containing articulated corallines with conceptacles located in sharply-pointed intergenicular lobes. The circumscription of the genus has been amplified, and now *Cheilosporum* is regarded as the only genus of the subfamily Corallinoideae which has conceptacles that are solely marginal in origin (Johansen, 1969). Conceptacle initiation occurs in incipient lobes on the margins of terminal or subterminal intergenicula. These lobes usually continue to grow distal to the developing conceptacles and eventually come to protude beyond the deeply embedded chambers. The pore of each mature conceptacle thus is located on the adaxial margin of the lobe (Figs. 5–6).

Seven species that have the characteristics mentioned above have been described on the basis of collections made in South Africa. First, Decaisne (1842b) described *Amphiroa* (Sec. *Cheilosporum*) *lamourouxiana* from plants in Lamouroux's herbarium in Caen. Then, Harvey (1847) described *Amphiroa* (Sec. *Cheilosporum*) *stangeri*, *A.* (*C.*) *flabellata* and *A.* (*C.*) *cultrata*, all from Port Natal (Durban), but the last species stated to occur also at Algoa Bay. In 1858 Kützing described *Amphiroa multifida* from the Cape of Good Hope and *A. heterocladia* from Port Natal, both species having characteristics of *Cheilosporum*. The last, the seventh South African species, *C. africanum*, was described by Manza (1937) from Still Bay, Cape Province, after a lapse of almost 80 years. In addition, since Lamouroux (1824) described *Corallina sagittata* from Mauritius, the type species of *Cheilosporum*, it has been reported to occur also in South Africa (Harvey, 1847, p. 102, as *Amphiroa sagittata*).

MATERIAL AND METHODS

Parts of the thalli to be studied were fixed and decalcified in Susa fixative (Suneson, 1937), usually under decreased pressure. The material was then embedded, sectioned (8 μm) and stained in Ehrlich's haematoxylin in the usual manner.

Most of the specimens examined were collected by: W. E. Isaac, G. F. Papenfuss, M. A. Pocock, R. F. Scagel, S. C. Seagrief, R. H. Simons, various researchers engaged in the Ecological Survey of South Africa from 1932 to 1940 under the leadership of T. A. Stephenson and by myself. These specimens and others are housed in the following herbaria: Albany Museum, Grahamstown, South Africa (GRA); Bolus Herbarium, incorporated into the Department of Botany, University of Cape Town in 1955 (BOL); British Museum (Natural History), London (BM); Clark University, Worcester, Massachusetts (CUW); Department of Botany, University of Cape Town, Rondebosch, where is housed the original set of the Ecological Survey collections (CT); Laboratoire de Botanique, Faculté des Sciences, Caen (CN); Naturhistoriska Riksmuseum, Stockholm (S); personal herbarium of G. F. Papenfuss (GFP), incorporated into the Herbarium of the University of California, Berkeley (UC); personal herbarium of M. A. Pocock (MAP), incorporated in the Herbarium of the Albany Museum, Grahamstown (GRA); Rhodes University, Grahamstown (RUH); Rijksherbarium, Leiden

(L); School of Botany, Trinity College, Dublin (TCD); University of California, Berkeley (UC).

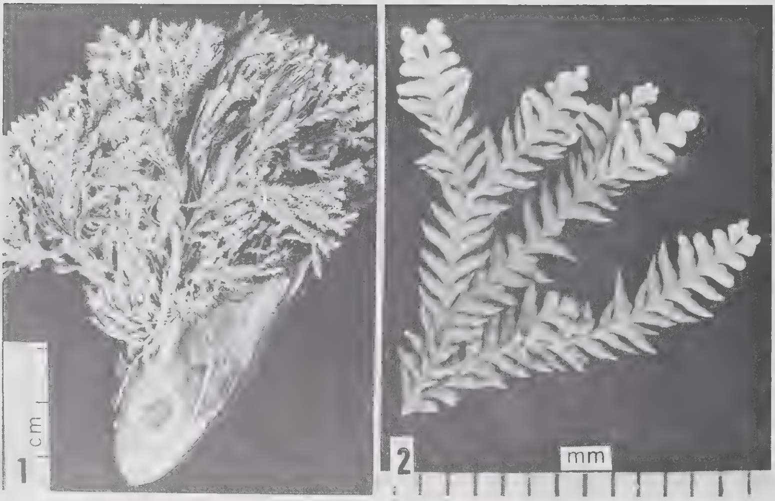
RESULTS

Anatomy

Most of the anatomical and reproductive details presented below were obtained from *Cheilosporum cultratum*. Features whereby *C. sagittatum* or *C. proliferum* differ from *C. cultratum* are pointed out in the systematic part of the paper.

Plants of *Cheilosporum cultratum* as well as of the other species arise in clusters from holdfasts consisting of entangled rhizomatous branches with barrel-shaped intergenicula (Fig. 18). Attachment disks (see Johansen, 1969), which serve to unite holdfasts and secure them to substrata, are present. The plants are usually epilithic, although sometimes they occur on fleshy or calcified algae and mollusc shells (Fig. 1). The development of sporelings and the formation of rhizomes were not studied.

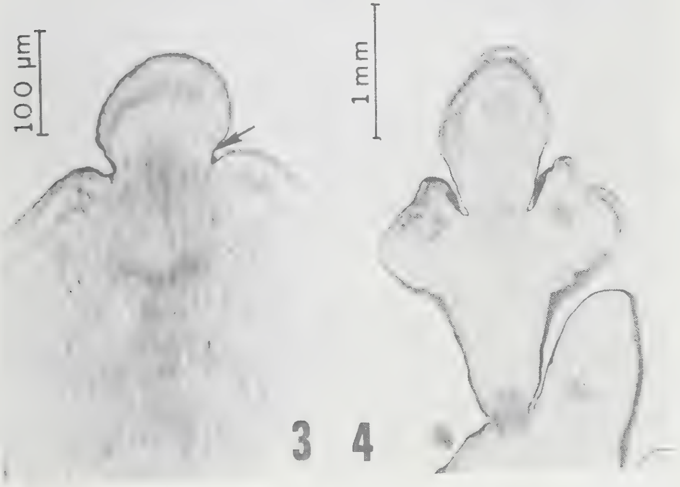
In the lower stipitate parts of the fronds, intergenicula are terete to subterete, about 1 mm long and 1 mm in diameter. Higher in the plant they are flat, up to 2 mm broad and 1 mm long, and each is provided with two characteristic, spreading lobes (Fig. 2).



FIGS. 1–2.
Cheilosporum cultratum ssp. *cultratum*. Fig. 1. Cluster of carposporangial fronds growing on a mussel; Kenton-on-Sea. Fig. 2. Part of a tetrasporangial frond in which most intergenicula bear four conceptacles; Kenton-on-Sea.

Branching is dichotomous. Secondary branches arising from intergenicular surfaces are rare in this species, and when present, they consist of few intergenicula (Figs. 19, 21). In *Cheilosporum proliferum* secondary branches are common and probably account for the specific name. The fronds of *C. cultratum* are usually no more than 6 cm high in tetrasporangial plants and less than that in sexual plants.

A branch consists of a core of achlorophyllous medullary filaments with the cells 90–115 μm long and so arranged that the end walls (and primary pit-connections) form arching, transverse lines in sectioned or decalcified material (Figs. 5, 12). The medulla branches inside each intergeniculum so that a core of filaments extends into each lobe. At intervals of about 1 mm there are tiers of cells only the ends of which are calcified; the uncalcified parts constitute the genicula (Figs. 3–6, 11, 15). These cells may be as much as 425 μm long, but they are only 6–9 μm wide. There is considerable variation in their length, the more peripheral cells being shorter. Genicula are 150–300 μm broad; the dimensions are larger for



FIGS. 3–4.
Longitudinal sections through the apices of branches of *Cheilosporum cultratum* ssp. *cultratum*. Fig. 3. Newly formed geniculum and intergeniculum. The bundle of elongate cells (arrow) constitutes the geniculum; the faint spots about midway between the top and bottom are nuclei; Storms River Mouth. Fig. 4. A penultimate intergeniculum each lobe of which contains a young conceptacle primordium. Note also the deeply staining meristematic cells at the branch apex and the two genicula, one between the young conceptacles and another below the fertile intergeniculum, the latter deeply stained; Kenton-on-Sea.

Cheilosporum proliferum. As in other members of the Corallinoideae, flanges, comprised of parts of the adjacent intergenicula, surround the genicula.

All medullary cells are formed by synchronous transverse divisions at the apices of the branches. Branching from peripheral medullary cells in the intergenicular regions (not from genicular cells) results in the formation of cortical filaments that consist of short (up to 15 μm long), plastid-containing cells. Hence, a cortex, 25–40 μm thick in *Cheilosporum cultratum* and *C. sagittatum*, or somewhat thicker (up to 80 μm) in *C. proliferum*, invests the medulla. Surmounting each cortical filament is a cover cell which, when many are taken collectively, comprise a cover cell layer or epithallium. These cover cells are up to 6 μm long and, as in other corallines, have characteristic, peripheral, uncalcified walls which form a more or less continuous cuticle over calcified parts of the plant. All intergenicular cells are 6–10 μm in diameter. They are sometimes joined laterally by large open fusions.

Reproduction

In fertile intergenicula one or two (rarely three) conceptacles form an integral part of each lobe; they are easily recognized by characteristic bulges (Fig. 2). As described earlier, the lobes and conceptacle positions are distinctive of the genus *Cheilosporum* (Figs. 5, 6).

Tetrasporangial conceptacle primordia first appear on the pronounced shoulders of penultimate intergenicula (Figs. 4–5) where they originate at the ends of medullary filaments; they are thus marginal and medullary in origin (see Johansen, 1969). During development the shoulders in which the conceptacles are located grow upward and outward and become lobes.

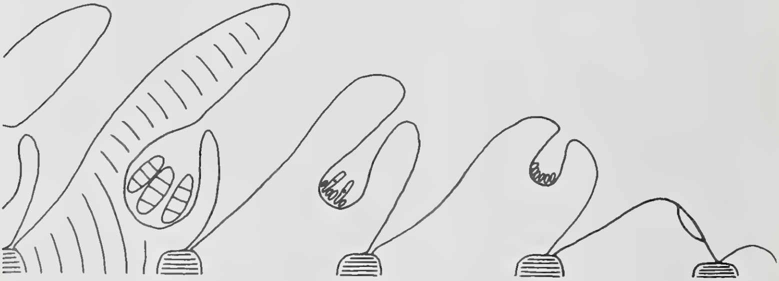
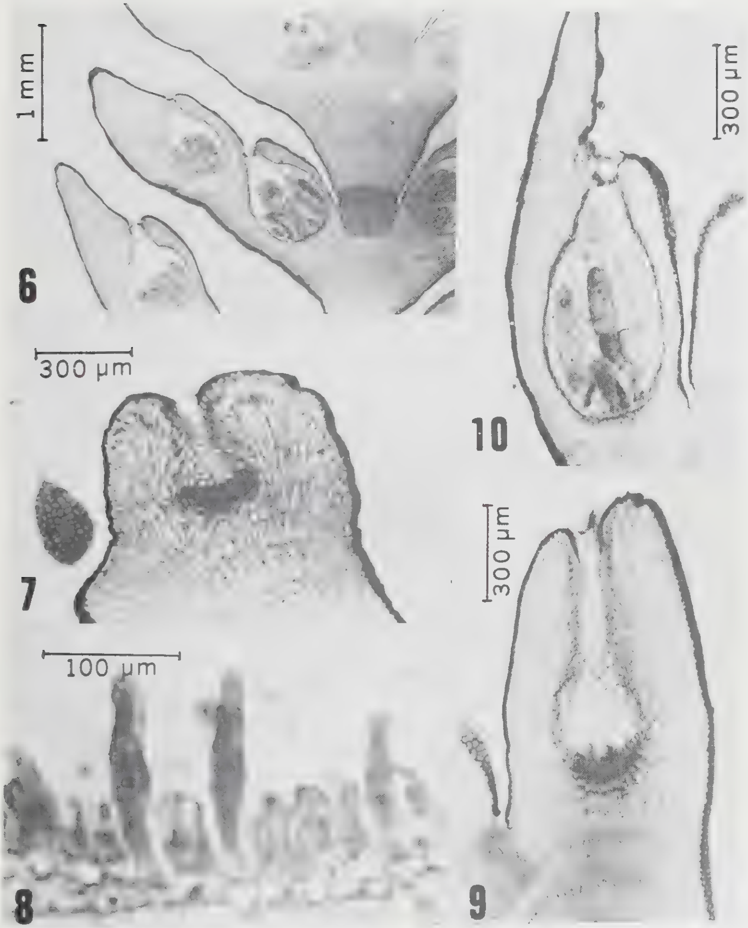


FIG. 5.
Diagram of half of a fertile branch of *Cheilosporum* showing stages in conceptacle maturation and enlargement. The shapes apply most nearly to tetrasporangial and female-carposporangial conceptacles, not to male conceptacles. In one of the lower intergenicula are shown arching lines indicating the lengths of the medullary cells.

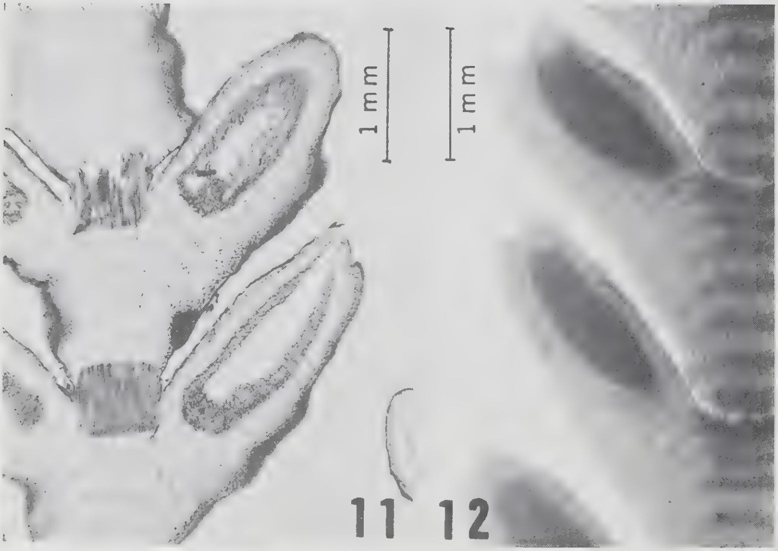


Figs. 6–10.

Sections of tetrasporangial conceptacles of *Cheilosporum cultratum* ssp. *cultratum*. Fig. 6. Part of branch in which there are two mature conceptacles per intergenicular lobe; Kenton-on-Sea. Fig. 7. Conceptacle primordium in which the deeply-stained sporangial initials are surrounded by rapidly growing tissue destined to form the conceptacle roof; Storms River Mouth. Fig. 8. Fertile layer at base of conceptacle in which some of the pre-meiotic tetrasporangia have elongated; Storms River Mouth. Fig. 9. Conceptacle containing pre-meiotic sporangia such as those depicted in Fig. 8. Note geniculum in lower left and the fact that the lobe has elongated unevenly around the fertile area; Storms River Mouth. Fig. 10. Conceptacle containing tetrasporangia; Storms River Mouth.

A tetrasporangial conceptacle primordium consists of a stratum of cells that have differentiated from meristematic cells terminating medullary filaments. These cells are protected by a conceptacle cap of cuticular strata (just as in the female, Fig. 13). Later, usually after the cap is lost, reproductive initials form on the floor of the chamber (Fig. 7). At this time a pronounced development of the tissue surrounding each patch of tetrasporangial initials takes place with the result that the initials come to be located at the base of a deep, narrow cavity (Fig. 9). Growth is asymmetrical with abaxial tissue developing more rapidly than adaxial tissue so that the pore eventually opens on the upper or adaxial surface of the lobe (Fig. 5).

While the surrounding tissues are growing, the tetrasporangial mother cells divide transversely so as to form young tetrasporangia subtended by small stalk cells. At first these sporangia are all approximately the same size, but later certain of them elongate more than their neighbours (Fig. 8). These attain a length of about 100 μm, after which meiosis (presumably) occurs. The four nuclei become evenly spaced on the long axis of the sporangium. Cytokineses are synchronized within each tetrasporangium, and cells undergoing this process are 150 to 200 μm long (Fig. 10). At any one time 10 to 15 post meiotic tetrasporangia may be



Figs. 11–12.
Male conceptacles of *Cheilosporum cultratum* ssp. *cultratum*; Kenton-on-Sea. Fig. 11. A sectioned branch. Fig. 12. A decalcified branch. Note that the conceptacular pores arise on the abaxial surface of the lobes as indicated by the small abaxial processes.

present in a conceptacle; usually numerous small undeveloped tetrasporangia also are present. Bisporangia were never seen in *Cheilosporum.*

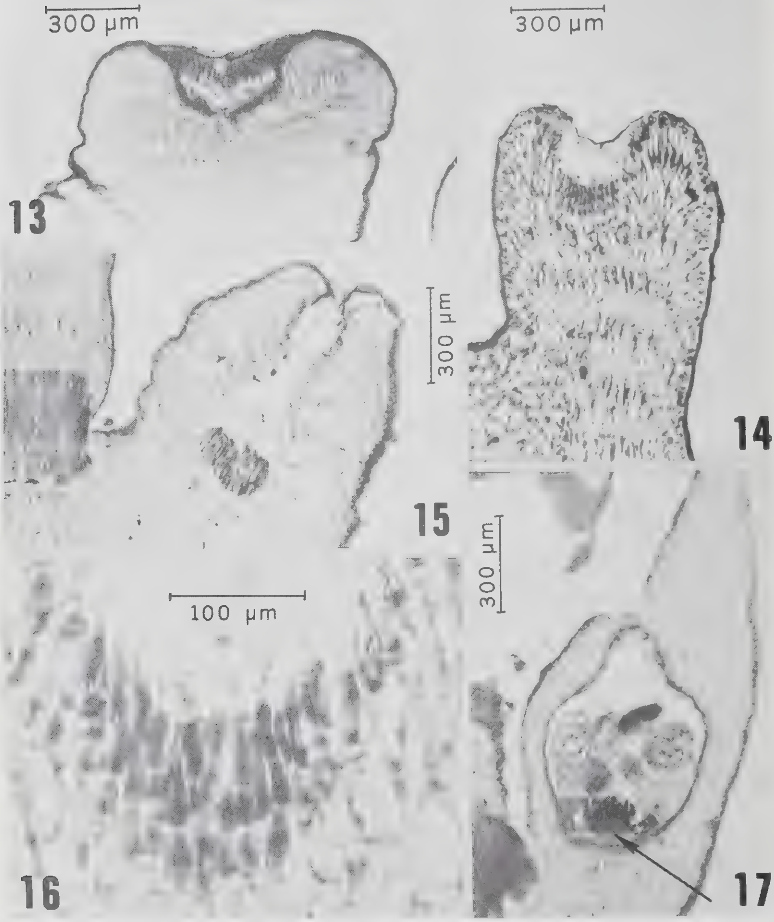
Sexual plants are much less common than tetrasporangial plants. The following description of male conceptacles is based on a few plants collected at Kenton-on-Sea. As in tetrasporangial conceptacles, male conceptacle primordia occur as depressions located on the shoulders of very young intergenicula; in the plants examined, there was never more than one male conceptacle per lobe. As the depression deepens, surrounding filaments continue growing while the filaments at the base of the developing chamber do not. The accentuated development on the abaxial side of the conceptacle observed in tetrasporangial plants is manifested in male plants in a small abaxial spur (Figs. 11–12). Male plants are readily recognized in the field by the fact that the conceptacular swellings are more elongated than in tetrasporangial and carposporangial plants. Also, in a male conceptacle the surface from which reproductive cells (spermatangia) are produced is more extensive, spermatangia occurring on the walls of the chamber as well as on the floor (Fig. 11). Enormous numbers of spermatangia are produced.

The female plants which were studied were collected at Port Alfred and Kenton-on-Sea. Early stages of development are similar to those in tetrasporangial and male plants. As the depression deepens because of circumconceptacular growth, a group of about 150–200 cells terminating filaments at the base become differentiated into intensely staining reproductive initials (Figs. 14–16). They eventually cut off one or two carpogonial filament initials, some of which divide transversely to form 2-celled carpogonial filaments, with the carpogonia bearing long trichogynes. By this time, the female conceptacles are fully formed (Fig. 15) and contain numerous procarps, the more peripheral of which are incompletely developed.

Presumably following fertilization the supporting cells fuse to form a thick, biconvex fusion cell 40 to 70 μm broad and 20 to 30 μm thick (Fig. 17). From the margins of this cell arise the carposporangial filaments, the terminal cells of which become carposporangia 50–70 μm in diameter.

Description of Cheilosporum

Substratum: rock, less often shells or algae; *Holdfasts:* entangled segmented branches consisting of terete or subterete, barrel-shaped intergenicula; *Fronds:* in clumps several centimeters high; *Branching:* dichotomous, secondary proliferous branches sometimes produced; *Intergenicula:* vegetative intergenicula flat, bilobed, lobes projecting distally and diverging much or only a little, lobes often acute, sometimes obtuse; *Genicula:* single cellular tier, cells thick-walled and deeply-staining, ends of cells calcified and embedded in adjacent intergenicula, uncalcified portion of genicula 200–500 μm long; *Medulla:* apical growth occuring at branch tips and, for a limited time, at lobe apices, synchronous divisions and periodic formation of genicula resulting in 5–15 medullary tiers per intergenicu-



Figs. 13–17.

Female and carposporangial conceptacles of *Cheilosporum cultratum* ssp. *cultratum*. Fig. 13. Conceptacle primordium with cap intact; Kenton-on-Sea. Fig. 14. Slightly older conceptacle in which the carpogonial systems have begun to form on the floor of the chamber; Port Alfred. Fig. 15. Older female conceptacle in which there is a hint of trichogynes. Note the geniculum to the left; Port Alfred. Fig. 16. Carpogonial filaments prior to the growth of trichogynes; Port Alfred. Fig. 17. Carposporangial conceptacle. The fusion cell is indicated by the arrow. A gonomoblast filament is emanating from the right side of the fusion cell; Port Alfred.

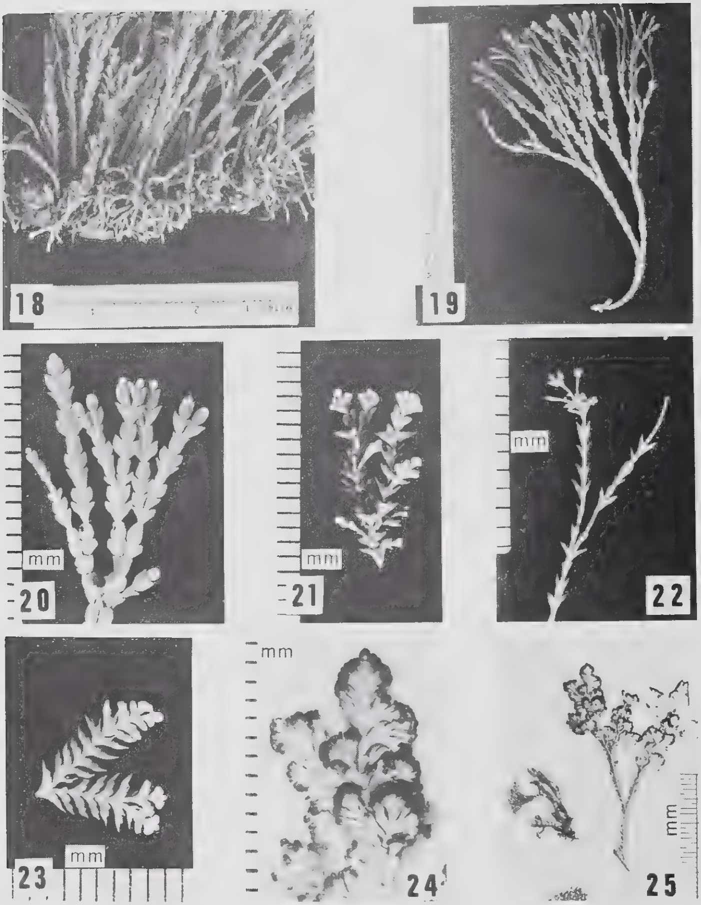
lum, each tier about 80–115 μm high; *Conceptacles:* marginal in origin, one or two (or three) embedded in each lobe of fertile intergeniculum, pore usually on adaxial surface of lobe due to greater growth of abaxial part of lobe; *Tetrasporangial conceptacles:* young conceptacles containing up to 200 tetrasporangial mother cells covering an area less than 150 μm in diameter, in mature conceptacles fewer than 15 tetrasporangia undergoing cytokineses at any one time, tetrasporangia 150–250 μm long; *Sexual plants:* dioecious, usually smaller and more densely bestowed with conceptacles than tetrasporangial plants; *Male conceptacles:* swelling prominently in adaxial part of lobe, chamber 150–250 μm in diameter, canal up to about 120 μm long, fertile surface covering narrow convex floor and high walls of chamber; *Female conceptacles:* chamber about 100 μm in diameter, about 150–200 supporting cells per conceptacle, each bearing 1 or 2 carpogonial filaments; *Carposporangial conceptacles:* chamber 200–260 μm in diameter, fusion cell 20–35 μm thick and 40–70 μm in diameter, with convex upper surface, carposporangial filaments arising from margin of fusion cell, carposporangia 50–70 μm in diameter.

Lectotype species: Cheilosporum sagittatum (Lamouroux) J. Areschoug (Schmitz, 1889, p. 455).

The taxa in Cheilosporum

Features useful in distinguishing among the taxa of *Cheilosporum* in South Africa are shown in Table 1. The characteristics and their variants as used in this table are given below:

1. Lobe Angle (in degrees, see Fig. 26). That angle formed between two lines, one bisecting the intergeniculum along its long axis and the other extending from the midpoint of the lower intergenicular margin to the tip of a lobe.
2. Lobe Complexity.
   sim = Lobes simple.
   inc = Lobes in part broad, flat and incised.
3. Intergenicular Length (in millimeters). As measured along the axis of the upper lobed intergenicula.
4. Medullary Tiers: The number of tiers per intergeniculum.
5. Proliferous Branches: Small branches arising from the intergenicular surfaces in lower parts of fronds:
   rar = Rarely present.
   oft = Often present.
6. Diameter of Stipitate Intergenicula (in millimeters). Referring only to lower intergenicula lacking lobes.



Figs. 18–25.

Photographs of the taxa of *Cheilosporum* treated in this paper. Fig. 18. Basal part of *C. proliferum* showing holdfasts of rhizome-like branches; Injambili River Mouth (Natal Province). Fig. 19. Frond of *C. proliferum* from which several short proliferous branches have arisen; Injambili River Mouth. Fig. 20. *C. proliferum* with a variety of intergenicular shapes; Injambili River Mouth. Fig. 21. A piece of frond from an old plant of *C. proliferum* bearing several adventitious outgrowths; Injambili River Mouth. Fig. 22 *C. sagittatum* in which some of the intergenicula lack lobes. The branch on the left is infected with *Choreonema thurettii*; Southbroom, Natal Province. Fig. 23. *C. cultratum* ssp. *cultratum* in which the intergenicula each contain four conceptacles; Kenton-on-Sea. Fig. 24. *C. cultratum* ssp. *multifidum* showing the characteristic incised lobes and the blackened branch tips; Platboom Bay. Fig. 25. *C. cultratum* ssp. *multifidum*. The lower intergenicula do not have incised lobes; Platboom Bay.

TABLE 1.
Principal features distinguishing the taxa of *Cheilosporum* in South Africa. Characteristics and variants given above.

	1	2	3	4	5	6
C. cultratum ssp. *cultratum*	>60	sim	0,7–1,1	6–10	rar	0,3–0,8
C. cultratum ssp. *multifidum*	>60	inc	0,7–1,1	—	rar	0,3–0,8
C. proliferum	<60	sim	1–2	9–15	oft	0,5–1
C. sagittatum	<60	sim	0,5–1,5	5–8	rar	0,1–0,4

Cheilosporum cultratum (Harvey) J. Areschoug (1852, p. 545) ssp. **cultratum** (Figs. 12, 23, 27). *Amphiroa (Cheilosporum) cultrata* Harvey (1847, p. 102, pl. 39, Figs. 1–3).

Amphiroa cultrata var. *pectinata* Kützing (1858, p. 27, pl. 55, figs. 2g–2i). *Cheilosporum cultratum* var. *pectinata* (Kützing) Yendo (1905, p. 19).

Like the genus but also: fronds up to 60 (–90) mm high; secondary proliferous branches rarely present; branch tips often blackening on drying; intergenicula in holdfasts and lower part of stipe 0,3–0,8 mm long and 0,3–0,8 mm diameter; lobed intergenicula 0,7–1,1 mm long and 1,5–3 mm broad between lobe apices; lobes of vegetative intergenicula usually simple and acute; lobe angles more than 60 degrees (see Fig. 26); 6–10 tiers of medullary cells per intergeniculum.

Type: "Port Natal" (Durban area of South Africa); collected by *Guenzius (TCD!).*

Known distribution in Africa: Southern Mozambique to Platboom Bay near the Cape of Good Hope, South Africa.

REPRESENTATIVE COLLECTIONS EXAMINED

SOUTH AFRICA, specific locality unknown: type of *Amphiroa cultrata* var. *pectinata* Kützing *(L 938,334 . . . 27).*

CAPE PROVINCE: Platboom Bay, male, 19 Dec. 1956, *Pocock 11949* (GRA, CUW); St. James, tetrasporangial, 14 Mar. 1967, *Johansen SA3–180c* (CUW); Riet River, 15 Feb. 1961, *Seagrief 1495 (Pocock 13406)* (RUH); Port Elizabeth, 4 July 1936, *Ecol. Surv. E. 6* (CT); Still Bay, 21 Jan. 1932, *Ecol. Surv. S. 78* (CT); Morgans Bay, carposporangial, 5 Oct. 1951, *Pocock 11757* (GRA); Plettenberg Bay, 10 Feb. 1959, *Isaac B759* (CT); Third Beach, Port St. Johns, 2 Dec. 1962, *Papenfuss and Scagel PR–XLI–56* (UC).

NATAL PROVINCE: Isipingo Beach, *Isaac* (CT); Isipingo, 29 June, 1935, *Ecol. Surv. D. 6* (CT); "Port Natal," *Guenzius (L 939,6 . . . 40)*; "Port Natal," labelled *Amphiroa cultrata* Harvey, *Guenzius* (S); Port Edward, 20 Sept. 1960, *Simons 2204* (CT).

MOZAMBIQUE: Lighthouse Rocks, Cabo Inhaca, Inhaca Island, 26 Sept. 1957, *Pocock 12133* (CUW); 10 Nov. 1962, *Papenfuss and Scagel PR–XXII–135* (UC); Xai-Xai, 10 July 1956, *Isaac B357* (CT); 2–3 Nov. 1962, *Papenfuss and Scagel PR–XIX–106* (UC); Zavora Reef, 4 Nov. 1962, *Papenfuss and Scagel PR–XX–6* (UC).

Cheilosporum cultratum subsp. **multifidum** (Kützing) comb. nov. (Fig. 24, 25, 28). *Amphiroa multifida* Kützing (1858, p. 27, pl. 56, figs. a–b).

Cheilosporum multifidum (Kützing) Manza (1937, p. 571). *Cheilosporum cultratum* f. *multifidum* (Kützing) Yendo (1905, p. 19).

Type: South Africa ("Caput bonae spei"). A specimen sent by *Lappe (L 938,334 . . . 28!).*

Known distribution: Mpekweni, near Hamburg, Cape Province, to Platboom Bay near the Cape of Good Hope. Not reported elsewhere.

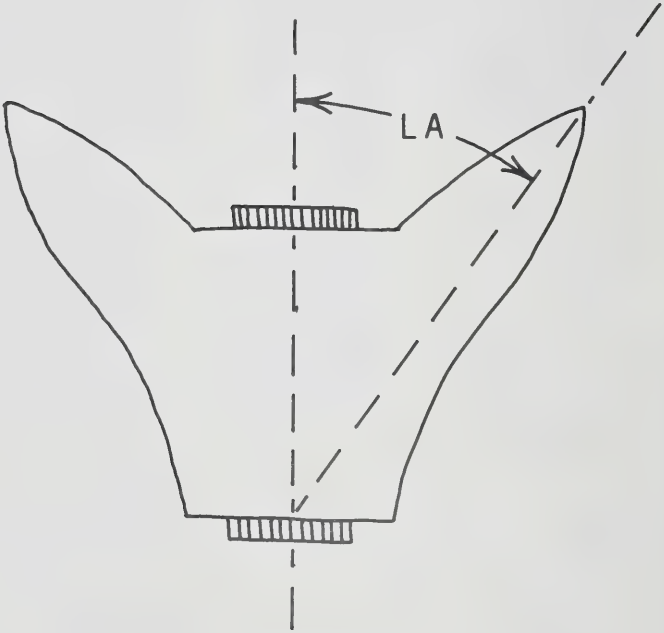


FIG. 26.
Diagram showing how the lobe angle (LA) is determined.

Representative Collections Examined

SOUTH AFRICA, specific locality unknown: *Lappe* (L *939,69 . . . 32*).
CAPE PROVINCE: Platboom Bay, 19 Dec. 1956, *Pocock 11950* (GRA, BOL); Cape Agulhas, 27 Feb. 1937, *Pocock 10915* (GRA), *Papenfuss 74* (UC 564609); Kowie Point, near Port Alfred, tetrasporangial, 15 Apr. 1956, *Pocock 11343* (GRA); Mpekweni, near Hamburg, 19 Jan. 1957, *Pocock* (CUW).

Cheilosporum proliferum (Lamouroux) DeToni (1905, p. 1833). (Figs. 18–21, 30–34). *Corallina prolifera* Lamouroux (1816, p. 291, pl. 10, fig. 5).

Arthrocardia prolifera (Lamouroux) Descaisne (1842a, p. 359). *Amphiroa (Arthrocardia) prolifera* (Lamouroux) Descaisne (1842b, p. 125). *Amphiroa (Cheilosporum) stangeri* Harvey (1847, p. 101, pl. 39, fig. 1–3). *Cheilosporum stangeri* (Harvey) Areschoug (1852, p. 544). *Amphiroa (Cheilosporum) flabellata* Harvey (1847, p. 101, pl. 39, figs. 1–4). *Amphiroa heterocladia* Kützing (1858, p. 28, pl. 58, figs. f–h).

Like the genus but also: fronds up to 100 mm high; short secondary proliferous branches containing fertile intergenicula common; intergenicula in holdfasts and lower part of stipe 0,5–2 mm long and 0,5–1 mm diameter; lobed intergenicula 1–2 mm long and up to 3,5 (–6) mm broad between lobe apices; lobes of vegetative intergenicula acute or obtuse; lobe angles less than 60 degrees (see Fig. 26); fertile intergenicula in main branches usually smaller than vegetative ones; fertile intergenicula near branch tips or in proliferations usually very much smaller, about 1,5 mm long and 1,5 mm broad between lobe apices; 9–15 tiers of medullary cells per intergeniculum.

Type: Madascar ("Indes Orientales," see Papenfuss, 1952, p. 169) sent by *Jussieu* (CN!).

Known distribution in Africa: Northern Mozambique to Still Bay, Cape Province.

Representative Collections Examined

CAPE PROVINCE: Still Bay, type of *Cheilosporum africanum* Manza, 26 Jan. 1932, *Ecol. Surv. S.80* (UC *564605*; isotypes in UC *564604* and CT); Storms River Mouth, tetrasporangial, in drift, 9 May 1967, *Johansen SA5–223* (CUW); Lighthouse Beach, Port Elizabeth, in drift, 10 Dec. 1962, *Papenfuss and Scagel PR–XLIX–B–26* (UC); Bashee River Mouth, 27 Sept. 1939, *Pocock 1766* (GRA).
NATAL PROVINCE: "Port Natal," type of *Amphiroa stangeri* Harvey, *Guenzius* (TCD!; isotypes in BM! and S!; "Port Natal" labelled *Amphiroa heterocladia* Kützing, *Guenzius* (S!); "Port Natal" type of *Amphiroa flabellata* Harvey, *Guenzius* (TCD!); Port Edward, 30 Nov. 1962, *Papenfuss and Scagel PR–XXXVIII–94* (UC); Isipingo, 29 June 1935, *Ecol. Surv. D.6* (CT); Reunion Rocks 27 Nov. 1962, *Papenfuss and Scagel PR–XXXIV–89* (UC); Chakas Rocks, 14 Oct. 1951, *Pocock 11743* (GRA).

MOZAMBIQUE: Xai–Xai, 2 and 3 Nov. 1962, *Papenfuss and Scagel PR–XIX–109* (UC).

Cheilosporum sagittatum (Lamouroux) J. Areschoug (1852, p. 545) (Figs. 22, 29). *Corallina sagittata* Lamouroux (1824, p. 625, pl. 95, figs. 11–12). *Arthrocardia sagittata* (Lamouroux) Decaisne (1842a, p. 359). *Amphiroa (Cheilosporum) sagittata* (Lamouroux) Decaisne (1842b, p. 125). *Cheilosporum sagittatum* f. *minor* DeToni (1905, p. 1832). *Amphiroa lamourouxiana* Decaisne (1842b, p. 125).

Like the genus but also: fronds up to 70–100 mm high; secondary proliferous branches rarely present; intergenicula in holdfasts and lower part of stipe 0,3–0,7 mm long and 0,1–0,4 mm diameter; lobed intergenicula 0,5–1,5 mm long and 1–1,5 (–1,8) broad between lobe apices; lobes of vegetative intergenicula usually simple and acute; lobe angles less than 60 degrees (see Fig. 26); 5–8 tiers of medullary cells per intergeniculum.

Type: Mauritius (''sur les rochers de l'Ile-de-France'') (CN!).

Known distribution in South Africa: St. Lucia Bay, Natal Province to Melkbosch, Cape Province.

REPRESENTATIVE COLLECTIONS EXAMINED

SOUTH AFRICA, specific locality unknown: type of *Amphiroa lamourouxiana* Decaisne, *Carmichael* (CN!).

CAPE PROVINCE: Melkbosch, in drift, 12 May 1967, *Johansen SA3–173d* (CUW); Storms River Mouth, tetrasporangial, 9 May 1967, *Johansen SA5–214* (CUW); Hamburg, 3 Dec. 1956, *Pocock 11884* (GRA); Port St. Johns, 7 July 1959, *Isaac B869* (in part) (CT); Fossil Head, 1 Dec. 1962, *Papenfuss and Scagel PR–XL–85* (UC).

NATAL PROVINCE: Trafalgar Port O'Call, in drift, 30 Nov. 1962, *Papenfuss and Scagel PR–XXXIX–80* (UC); Southbroom, 23 May 1967, *Johansen SA5–268* (CUW).

DISCUSSION

Studies of the *Jania/Haliptylon/Cheilosporum* complex have been few and most of our information is based on work on *Jania rubens* (L.) Lamour. (Suneson, 1937), *Jania radiata* Yendo (Segawa, 1946), *Jania iyengarii* Ganesan (Ganesan, 1965) and *Haliptylon subulata* (Ellis & Soland.) Johans. (Johansen, 1970) as well as the only other species of *Cheilosporum* to have been examined closely, *C. jungermannioides* (Rupr.) J. Aresch. (Segawa, 1941). From these and other works as well as the present study, it is clear that the distinctive genus *Cheilosporum* is closely related to *Jania* and *Haliptylon* although it is markedly different as far as conceptacle position is concerned. In *Jania* and *Haliptylon* conceptacles are axial in origin (Johansen, 1969, 1970), that is, the primordia (and the resulting conceptacles) are in line with the genicula subtending the fertile intergenicula.

Hence, an intergeniculum bears only one conceptacle, because the primordium usurps the space in line with the subtending geniculum. On the other hand, as described earlier in the present paper, the conceptacles are marginal in *Cheilosporum* and not in line with subtending genicula. Two or more conceptacles may thus be borne on a single intergeniculum, usually one in each of the two lobes.

Another result of having axial conceptacles is that the extension by growth of the axis of the branch is interrupted. In *Jania* and *Haliptylon* most fertile intergenicula bear two branches, but they are not in line with the axis of that intergeniculum. In *Cheilosporum* fertile intergenicula are intercalary in long branches that only periodically branch dichotomously. Therefore, fertile intergenicula do not interfere with branch systems.

Cheilosporum probably evolved from ancestors such as *Jania* or *Haliptylon* with the most distinctive feature separating it from these genera being conceptacles position. In fact, among the other aspects examined, no differences from *Jania* and *Haliptylon* were observed and the *Jania*/*Haliptylon* alliance can be considered to also include *Cheilosporum*.

It may prove useful to compare this three–member alliance with the remaining nine genera in the subfamily. The comparable differences are given in Table 2 in which *Corallina* represents these genera. Notably, *Corallina* exhibits features which are for the most part coarser than those in the alliance. The fact that most of these features are disjunct suggests that evolutionary routes resulting in these two groups of genera diverged a long time ago. These conclusions are supported by conceptacle morphology (see also Johansen, 1970, 1972).

TABLE 2.

The salient differences between *Cheilosporum* and its two close relatives *Jania* and *Haliptylon* on the one hand and *Corallina* on the other. This table is an updating and amplification of Table 1 (p. 84) in Johansen (1970).

CHARACTERISTICS	CHEILOSPORUM, etc.	CORALLINA
Height of intergenicular medullary tiers (μm)	80–170	50–90
Diameter of fertile area in conceptacles containing tetrasporangial initials (μm)	60–150	150–250
No. of tetrasporangial initials per conceptacle	<200	>200
No. of tetrasporangia undergoing cytokineses per conceptacle	5–15	30–40
Length of conceptacular canal in male conceptacles (μm)	<120	>200
Diameter of fertile area in female conceptacles prior to fertilization (μm)	60–120	150–200
No. of supporting cells per female conceptacle	<200	>200
Diameter of fusion cell (μm)	40–70	90–200

The principal characteristics used in distinguishing the three South African species of *Cheilosporum* are segment size, lobe shape, and the configuration of lobes in relation to the body of the intergeniculum. In spite of considerable variation in intergenicular size in non-stipitate parts of *C. proliferum*, the consistently larger and thicker segments of stipes and holdfast immediately set this species apart from the other two. In the upper part the lobes are either obtuse or acute in *C. proliferum* but nearly always acute in *C. sagittatum* and *C. cultratum*. The separation of *C. sagittatum* and *C. cultratum* is best carried out by comparing their so-called lobe angles in vegetative intergenicula in upper parts of the fronds. This angle is that formed between the intergenicular axis and a line connecting the lowermost point on that axis and one of the lobe apices (Fig. 26). This procedure accentuates the differences between the species because it takes into account the length of the lobe, the distance its apex is from the axis of the branch, and the length of the intergeniculum. The lobe angle is appreciably more acute in *C. sagittatum* than in *C. cultratum*.

Cheilosporum cultratum ssp. *cultratum* is characterized by plants with short intergenicula having relatively narrow and acute lobes that diverge widely from the branch axis (Fig. 2). In Natal Province the fronds are generally smaller and more delicate and, except for the lobe angles, some plants could be confused with those of *C. sagittatum*. Generally, plants of *C. cultratum* ssp. *cultratum* in Natal Province and northwards have a lower proportion of fertile to sterile intergenicula than do plants in the Cape Province. The area between East London and Cape Point harbours plants which are heavily beset with conceptacles, having one to three (usually one or two) conceptacles per lobe, with most upper intergenicula fertile. This subspecies occurs at least as far north as Xai-Xai, Mozambique, a village about 10 miles northeast of the mouth of the Limpopo River (Isaac, 1957). Its relationship to *Cheilosporum jungermannioides*, which has been reported from Kenya (Isaac, 1971), is unclear.

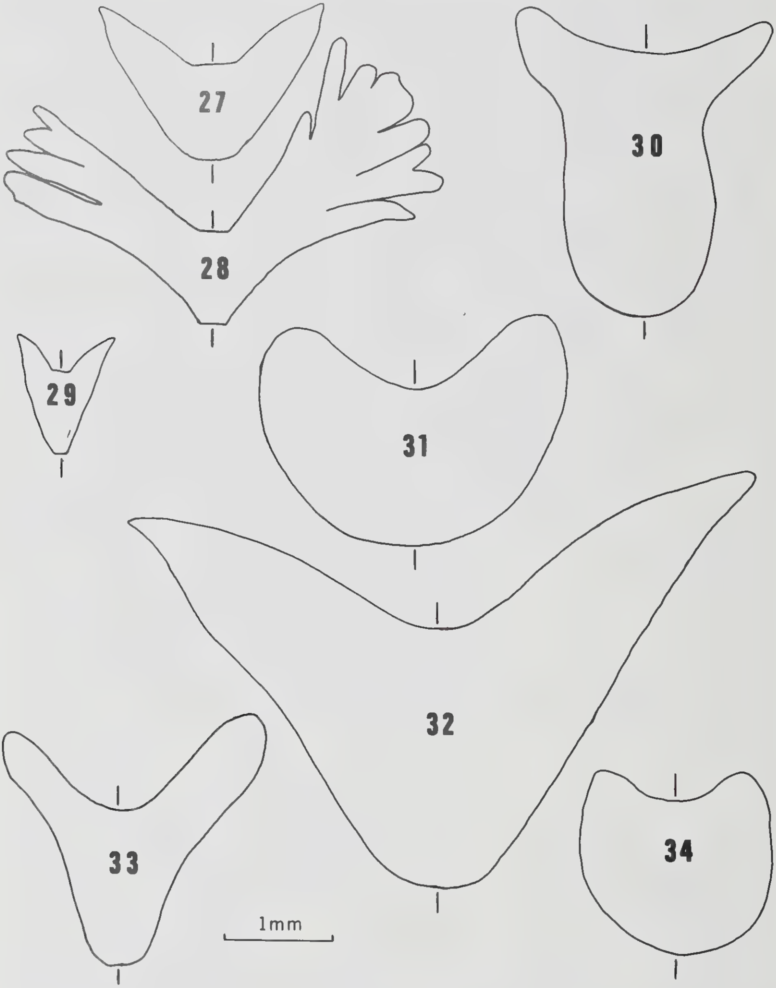
That *Cheilosporum cultratum* ssp. *cultratum* is characterized by plants of variable shape is evidenced by Kützing's (1858) separation of it (as *Amphiroa cultrata*) into three variaties; namely, *debilis*, *globulifera*, and *pectinata* (the first two *nomina nuda*), all of which were based on plants from South Africa. (It should be noted, however, that the variety *globulifera* was so named because of the ". . . eigenthümliche Kugeln . . ." (p. 27) which, in Kützing's figure (pl. 55, fig. I), may be seen to be conceptacles of the parasitic *Choreonema)*. Harvey (1847, p. 102) mentioned the three varieties but stated ". . . appearances probably caused by locality. In all, the form of the articulations is very similar." He considered them to represent forms of a single species. Furthermore, my placement in *C. cultratum* of what has often been considered a distinct species, *C. multifidum*, underscores the variation in form which thalli of this species possess. The presence of intergenicula characteristic of *C. cultratum* ssp. *cultratum* in parts of plants of *C. cultratum* ssp. *multifidum* makes the separation of the two as discrete species unrealistic. Plants of the latter are rare and usually have few, if any, conceptacles.

In South Africa plants of *Cheilosporum cultratum* ssp. *cultratum* and *C. sagittatum* may, in most instances, be easily distinguished in the field. In addition to intergenicular shape, South African specimens may be distinguished by the purple colour of the former and the red-pink colour of the latter. Furthermore, the tips of the fronds of both subspecies of *C. cultratum* often blacken upon drying (Fig. 24–25; see also the water-colour painting in Seagrief, 1967, p. 127); this does not occur in *C. sagittatum*. *Cheilosporum cultratum* ssp. *cultratum* is more abundant in intertidal tide pools than is *C. sagittatum*, often forming soft tufts on mussels or rocks.

Cheilosporum proliferum has intergenicula which are, for the most part, longer, broader, and thicker than those of *C. cultratum* and *C. sagittatum*. Therefore, intergenicular size, and especially the more consistently larger segments of the rhizomes and lower stipe, enable one to readily identify this species. In this species particularly, intergenicula in upper parts of the fronds are extremely variable in both size and shape. The factors that account for this great variability are not clear, but probably involved are frond age, the season in which the intergenicula were produced, localities in which the plants grew (with all attendant factors), and the proportions of the fronds given over to bearing conceptacles.

Plants of *Cheilosporum proliferum* change considerably in aspect as the fronds grow in length. Young fronds less than 5 cm long are sterile and usually have subterete to compressed, thick, and more or less round-lobed intergenicula (Figs. 30–31, 34). Subsequent growth may result in dichotomously branched fertile fronds in which conceptacles are present in some of the intergenicula near branch ends. When lobes are given over to bearing conceptacles, they do not develop to the extent as the sterile lobes. Also, the apices of fertile lobes are nearly always acutely pointed, whereas sterile lobes are often subacute or obtuse. Whether fertile or not, intergenicular size usually decreases at each dichotomy and branch ends may consist of short segments only 1–1,5 mm broad between lobe apices. Finally, the tendency for crops of secondary proliferous branches to be produced in older plants is more pronounced in this species than in the other two species of *Cheilosporum*. Usually, the secondary branches issue from flat surfaces of intergenicula in various parts of the fronds and reach a length of less than 20 mm. Most secondary branches are fertile and have small intergenicula (Fig. 21) in which most of each lobe consists of a conceptacle. Most, if not all, members of the Corallinoideae have this ability to produce secondary branches, but *C. proliferum* is often especially proliferous and a specimen of this nature apparently inspired the epithet. The extent to which the other factors mentioned above may help to account for variation in intergenicular morphology is unclear.

As shown in Figures 30–34, vegetative intergenicula may be variously shaped. The most frequently encountered shape has simple spreading acute lobes (Fig. 32).



FIGS. 27–34.

Traced outlines of intergenicula in the species of *Cheilosporum* treated in this paper. Fig. 27. *C. cultratum* ssp. *cultratum*; St. James. Fig. 28. *C. cultratum* ssp. *multifidum*; Port Alfred. Fig. 29. *C. sagittatum*; Hamburg. Figs. 30–34. *C. proliferum*. Figs. 30, 31 and 33 from Storms River Mouth (drift); 34 from Injambili River Mouth; 32 from Still Bay (from type specimen of *C. africanum*).

Broadly rounded lobes (Fig. 31), spreading lobes issuing from only the upper part of the segment (Fig. 30), and rounded lobes appressed towards the intergenicular axis (Fig. 34) are less frequent. All of these types, as well as intergradations, may occur in one and the same frond and are not worthy of taxonomic recognition. Two or more intergenicular types may alternate with some regularity in a given branch or one type may predominate for a length of several segments only to be replaced higher in the frond by another type. Harvey's illustrations (1847, pl. 39) of two of his species, *Amphiroa (Cheilosporum) stangeri* and *A. (C.) flabellata*, also show these segment shapes.

It is noteworthy that *Cheilosporum* and *Jania* are abundantly represented by species of large plants (i.e. *Jania crassa* Lamouroux and *C. proliferum*) in the relatively warmer waters of Natal Province, whereas the general tendency in other genera (including non-corallinaceous genera) is for the smaller or more delicate species to predominate in warmer waters and the more robust species to occur in colder waters. To judge from Harvey's (1847) work, Dr. Pocock's collections, and personal field work, *C. proliferum* is the most abundant species of this genus in Natal Province, at least in the intertidal zone. *Cheilosporum proliferum* is present only in the subtidal zone on the southern coast of South Africa.

The varied appearance of intergenicula and branches in *Cheilosporum proliferum* has led to the description of several species based on collections of this taxon made in South Africa. In 1847 Harvey, without mentioning *Corallina prolifera* Lamouroux, the binomial upon which *Cheilosporum proliferum* is based, erected *Amphiroa (Cheilosporum) stangeri* and *A. (C.) flabellata* from "Port Natal". An examination of the types of these species reveals plants that fall well within the circumscription of *C. proliferum*, as do also the types of *Amphiroa heterocladia* Kützing (1858) from Port Natal and *Cheilosporum africanum* Manza (1937) from Still Bay, Cape Province. Plate 58 of Kützing's work illustrates branches of Harvey's two species as well as of *A. heterocladia* and gives a further idea of the kinds of intergenicula present in *C. proliferum*.

To judge from previous reliable references to *Cheilosporum sagittatum* (e.g., Segawa, 1941; Joly, 1965, p. 137; Taylor, 1960, p. 408), it is evident that this species is widespread in tropical areas of the northern hemisphere as well as in the southern hemisphere. The main characteristic of this species is the sharply upswept, acute intergenicular lobes. The type specimen of this species is a relatively robust plant from Mauritius (Ile-de-France); most of the South African specimens are more delicate.

As in many other algae, plants of *Cheilosporum sagittatum* occurring in the sublittoral zone tend to be more spindly and laxly branched than those growing in the littoral zone (Johansen and Colthart, 1975). Also, specimens from Natal Province sometimes have more delicate intergenicula than those from cooler waters, although this may not always be true. This species is less frequently collected in the Cape Province than is *C. cultratum*, possibly because *C. sagitta-*

tum is generally restricted to the subtidal zone. Also, fertile specimens of *C. sagittatum* are less frequently encountered than are sterile specimens.

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GASTERIA BAYLISSIANA RAUH: A NEW DWARF *GASTERIA* FROM SOUTH-EAST AFRICA

Werner Rauh

(Institute of Systematic Botany of the University of Heidelberg, West Germany)

Abstract

A new dwarf *Gasteria* species from South-East Africa is described.

Uittreksel

GASTERIA BAYLISSIANA RAUH: 'N NUWE DWERG *GASTERIA* VANAF SUIDOOS-AFRIKA

'n Nuwe dwerg *Gasteria*-soort vanaf Suidoos-Afrika word beskryf.

Gasteria baylissiana Rauh, sp. nov.

Planta: nana, modice sobolifera, greges parvos formans; solitaria usque ad 30 mm alta, 10 cm diametiens. *Folia:* disticha; *Lamina:* supra plana, rectangulariter patens vel recurvata, ligulata, apice late rotundata, breviter mucronata, 40–50 mm longa, 20 mm lata, margine anguste cartilagineo-limbata, viridi-rufescenti-violacea, utrimque dense parvoque albido-verrucosa, itaque epidermide scabra; *Inflorescentiae:* singulariter erectae vel arcuatae usque ad 300 mm longae racemosae; *Scapus:* tenuis 80–100 mm longus, 2–3 mm diametiens, cano-violaceus, cereo-pruinosus; *Folia scapi:* 3–4 membranacea pergamentacea tenuia anguste triangulata usque ad 5 mm longa; *Racema:* 15–17 flora; *Bracteae florales:* parvae membranaceae pedicello rubro 10 mm longo breviores; *Flores:* penduli, zygomorphi, plus minusve 15 mm longi; *Perigonium:* basi breve angustum, deinde ventricoso-inflatum, postremo in tubum brevem sursum curvatum se angustans; *Tepala:* anguste linguiformia, basi connata, partibus liberis 5 mm longis, 2 mm latis, viridia, apicibus reflexis refescentia, marginibus albo-limbatis, nervis medianis obscuris; *Stamina et stylus:* tepalis breviora.

Type: Farm Oudekraal, South of Somerset East, on a steep slope in a dense shade and leaf mould; *R. D. A. Bayliss 2796*, 23.4.65. *(holotypus:* Herbarium of the Inst. of Systematic Botany of the University of Heidelberg (HEID. No. 30517); *isotypus:* National Herbarium, Pretoria (PRE).

Plant nearly stemless, succulent, suckering from the base, forming dense clumps (Fig. 1–2); a single plant becomes up to 30 mm high and up to 100 mm broad. *Leaves* strongly distichously arranged, ligulate, rounded at the apex, shortly mucronate, 30–50 mm long, 20 mm broad, somewhat horny on the margin (Fig. 3); upper surface flat, lower slightly convex, both sides covered with numerous small, white tubercles (Fig. 3), so that the greenish-reddish-violet epidermis

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becomes rough. *Inflorescences:* mainly unbranched simple (Fig. 4), lax; racemes with 15–17 flowers; the erect or arching scape is furnished with 4–5 thin, papery, triangular, reddish bracts. *Flowers:* pendant, zygomorphous (Fig. 4), red, ventricose near the base; tepals 5 mm long, 2 mm broad, greenish with a darker green midnerve and recurved reddish tips; stamens and style included.

Gasteria baylissiana is a beautiful new dwarf species of *Gasteria*, which was collected by Colonel Roy Bayliss near Somerset East in the Cape. About 4 years ago he sent a small living plant to me in Heidelberg (Germany). Since then it has been cultivated in the Heidelberg Botanical Garden. It has flowered every year and during this time has not altered its growth-form, its size and colour of the leaves. *G. baylissiana* is one of the smaller Gasterias like *G. brevifolia* Haw., *G. ernestii-ruschii* Dtr., *G. neliana* V. Poelln. (the two latter are only forms of *G. pillansii* Kensit.) and *G. liliputana* Poelln., but it differs from all these species by the color and structure of the leaf epidermis. In this point *G. baylissiana* resembles *G. batesiana* Roley, but this plant becomes much bigger, and the leaves are spirally arranged. One must, however, take note that in certain circumstances *G. baylissiana* exhibits some variations in habit. Col. Bayliss reports that his original plant, grown in dense shade in Grahamstown since 1965, is as in nature, a

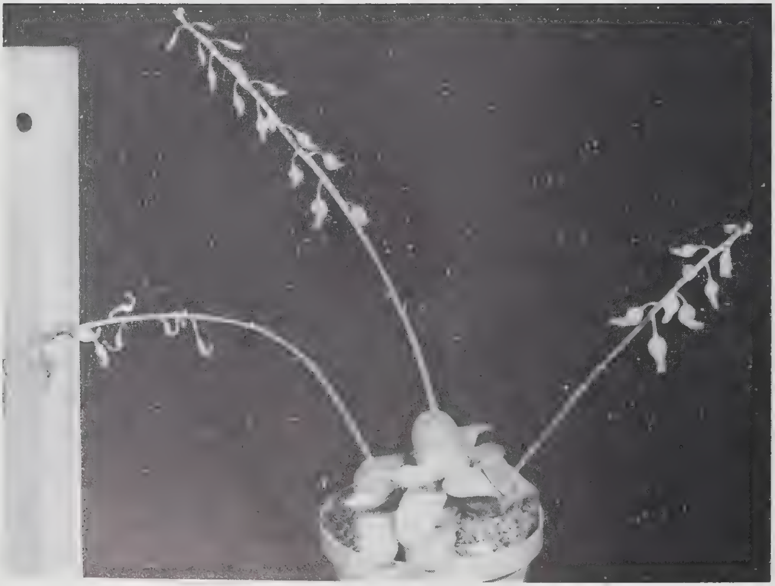

FIG. 1
Gasteria baylissiana; type. Holotype.

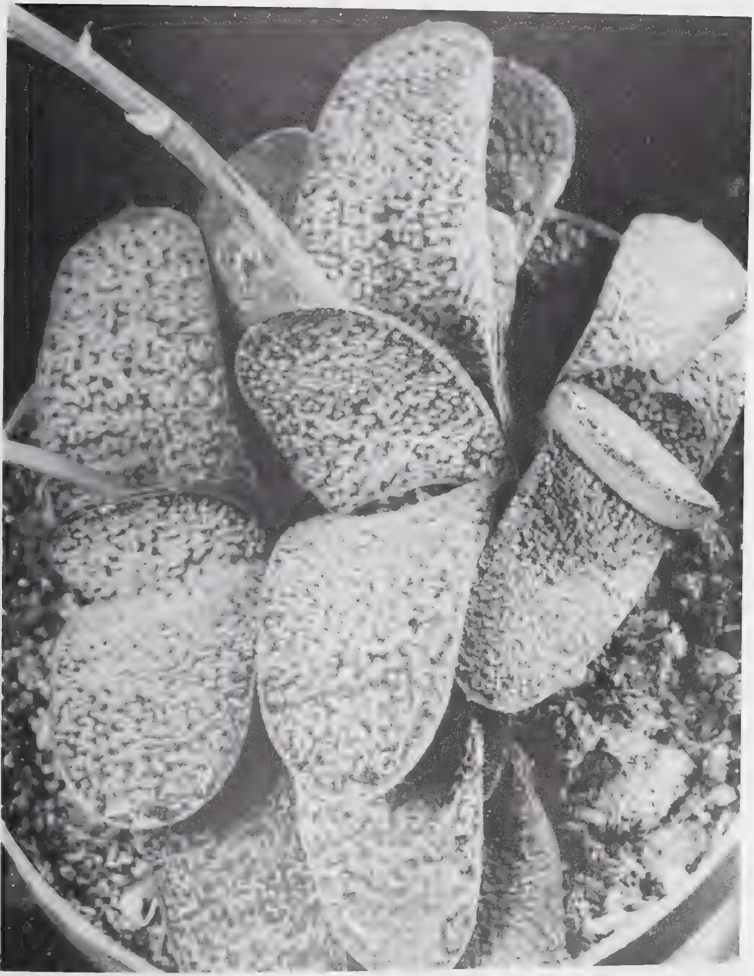

Fig. 2

Cluster of *Gasteria baylissiana* in cultivation (Bot. Garden, Heidelberg)

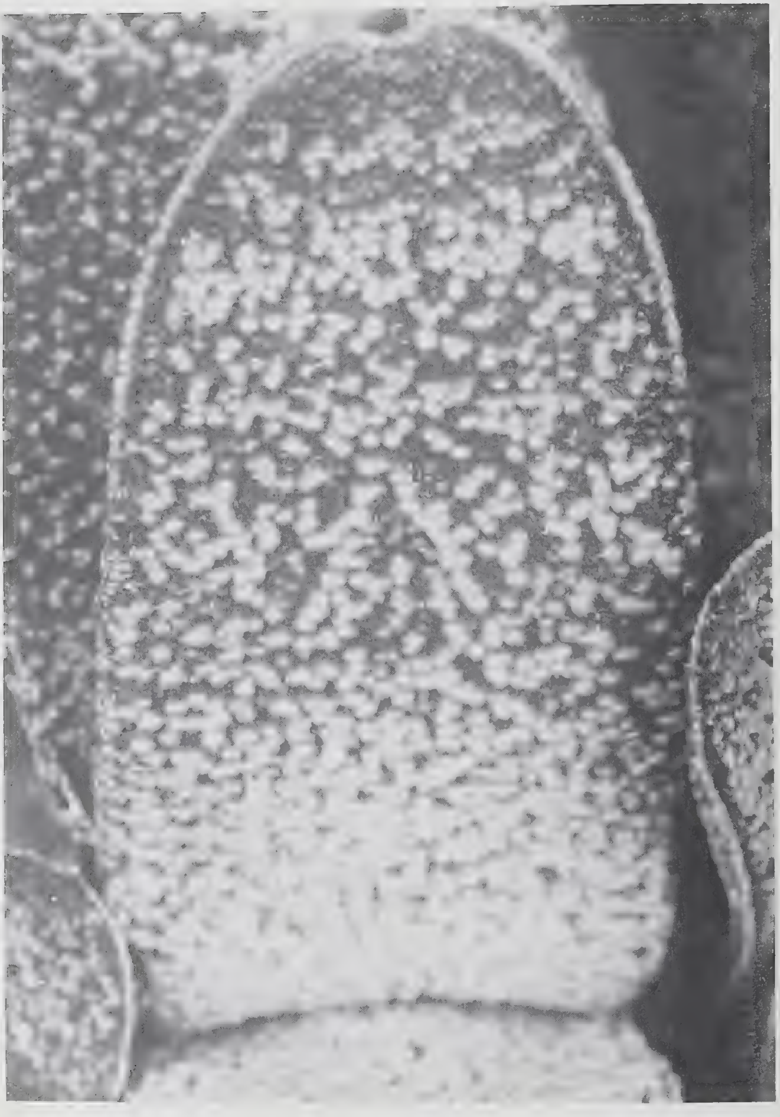

FIG. 3
Gasteria baylissiana, leaf surface.

compact group of suckers as depicted in the type plant, grown in Heidelberg, Germany. A second plant, grown under greenhouse conditions in Grahamstown and used for the distribution of suckers to the Botanical Research Institute, Pretoria and other institutions, has more elongated leaves, up to about 100 mm long and 15–20 mm broad. These plants may produce up to three inflorescences a season, sometimes vigorous and branched. The shape and the colour of the flowers, the texture and the surface of the leaves are the main diagnostic characters of this remarkable species.

ACKNOWLEDGEMENTS

I am very indebted to Col. Bayliss for sending living plants to the Heidelberg Botanical Garden and giving me the permission to dedicate to him this decorative plant; I am furthermore indebted to Dr. R. A. Dyer for the revision of the description of the new *Gasteria*.

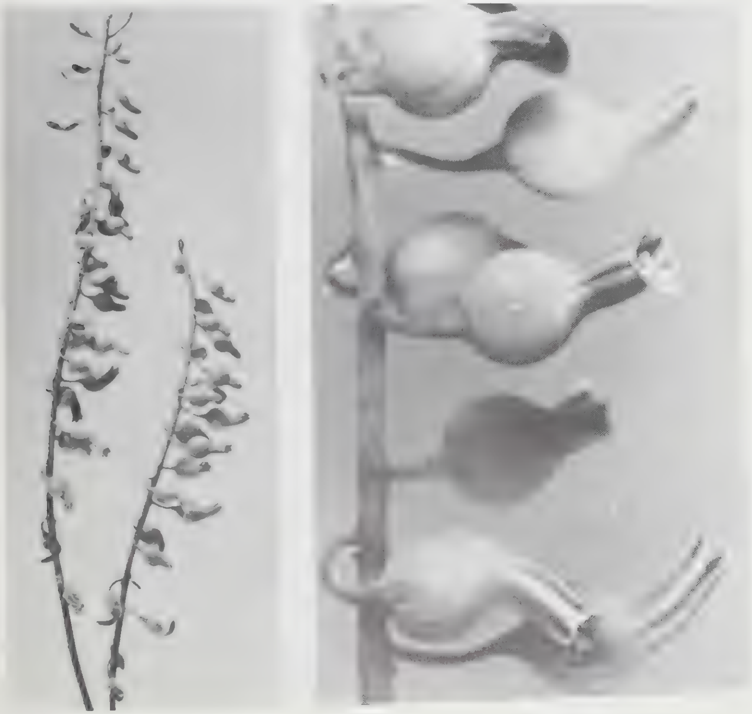

FIG. 4

Gasteria baylissiana, left: 2 inflorescences right: flowers enlarged.

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THERMOPHILIC FUNGI ASSOCIATED WITH THE CULTIVATION OF *AGARICUS BISPORUS* (LANGE) SINGER

Albert Eicker

(Department of Botany, University of Pretoria)

Abstract

Thermophilic fungi were isolated from compost used in experimental mushroom culture. Three methods, the moist chamber, direct plating and dilution plate methods were used at intervals during the process of cultivation to study the occurrence and succession of these specialized fungi up to the stage of the formation of the first sporophores.

Ten species of thermophilic moulds were isolated. They were *Aspergillus fumigatus, Chaetomium thermophile* var. *dissitum, Humicola grisea* var. *thermoidea, Humicola insolens, Humicola lanunginosa, Malbranchea pulchella* var. *sulfurea, Mucor miehei, M. pusillus, Talaromyces duponti* and *Torula thermophila*. The frequency of occurrence of six dominant thermophiles is considered in detail and correlated with the variation in compost temperature.

Uittreksel

TERMOFIELE FUNGI GEASSOSIEER MET DIE KWEEK VAN *AGARICUS BISPORUS* (LANGE) SINGER

Termofiele fungi is uit kompos van 'n eksperimentele sampioenkwekery geïsoleer. Drie metodes nl. vogtige kamer, direkte uitplating en verdunningsplate is gebruik om die voorkoms en suksessiepatrone van hierdie gespesialiseerde fungi tydens die hele proses van sampioenkweking tot en met die verskyning van die eerste vrugliggame na te gaan. Tien termofiele fungi is geïsoleer. Hulle is *Aspergillus fumigatus, Chaetomium thermophile* var. *dissitum, Humicola grisea* var. *thermoidea, Humicola insolens, Humicola lanunginosa, Malbranchea pulchella* var. *sulfurea, Mucor miehei, M. pusillus, Talaromyces duponti* en *Torula thermophila*. Die frekwensie van voorkoms van ses dominante termofiele word in besonderhede bespreek en in verband gebring met die variasies in kompostemperatuur.

Introduction

During a study of thermophilic fungi occurring in South Africa, attention was turned to composting substrates used in the commercial cultivation of the mushroom *Agaricus bisporus* (Lange) Singer. The mushroom is grown in a mixture composed largely of wheat straw and horse manure. Before *A. bisporus* will grow well in this substrate it must undergo a certain amount of deterioration known as composting. The commercial preparation of mushroom compost in-

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volves two phases. Phase I is essentially a fermentation process resulting in the release of energy in the form of heat. This thermogenesis is favoured by aerobic conditions which are maintained by restricting the width and height of the compost piles and by repeated turning of the composting material. Internal pile temperatures may reach 80 °C or more during this stage. Phase II takes place in controlled temperature rooms after wooden trays have been filled with the compost. During this phase, known as ''peak heating'', the temperature within the compost is maintained between 50 and 60 °C by aeration of the room. The air temperature of the room is held in the range of 35–45 °C. It is now known that thermogenesis by micro-organisms initiates, at least the heating of Phase I and produces the heat in Phase II (Fergus, 1964).

Many micro-organisms associated with the composting process have been isolated and these include both mesophilic and thermophilic bacteria, actinomycetes and fungi (Bels-Koning, *et al.*, 1962; Hensen, 1957; Pope, Knaust & Knaust, 1962; Reese, 1946; Renoux-Blondeau, 1959 and Tendler & Burkholder, 1961). The first detailed study of thermophilic bacteria and fungi active in compost at temperatures in excess of 50 °C was that of Waksman, *et al.* (1939). More recent work has indicated the importance of thermophilic fungi in mushroom cultivation. Bels-Koning, *et al.* (1962) showed that the thermophilic species of *Humicola* are important in the composting process. The thermophilic and thermotolerant fungi and actinomycetes colonizing compost during peak heat were studied by Fergus (1964) while Cooney and Emerson (1964) and Fergus and Sinden (1969) described some thermotolerant fungi from mushroom compost. Chang and Hudson (1967) made an extensive study of the ecology of wheat straw compost and they isolated a number of thermophilic fungi. In a study of the microbial changes taking place in composting wheat straw/horse manure mixture Hayes (1968) found that thermophilic fungi belonging to the genera *Humicola, Mucor, Stilbella* and *Torula* were active at different stages in the composting process. Fordyce (1970) determined that many of the thermophilic fungi active in Phase I and Phase II of composting were also present in the compost during mushroom spawn development and sporophore production but that these fungi, particularly species of *Chaetomium, Humicola* and *Torula*, showed a definite decline in number as time progressed. Staněk (1972) concentrated on the period of peak fermentation in his study of thermophilic micro-organisms colonizing mushroom compost.

The aim of this study is to contribute to the present data on the importance of thermophilic fungi colonizing mushroom compost during the entire period, from the start of Phase I until the stage of the appearance of the first fruiting bodies. An attempt was also made to study the succession of these fungi in the compost and to determine their frequency of occurrence as the composting, spawn run (colonization of compost by mushroom mycelium) and sporophore development progressed. In order to do this a pilot plant was set up at the University of Pretoria where the whole process could be executed under strictly controlled conditions.

MATERIAL AND METHODS

Pilot mushroom cultivation

The approximate proportions of the ingredients that were used for the compost which was to be analysed microbiologically are shown in Table 1. The materials were thoroughly mixed and watered to bring the moisture content to about 78 %. On day 0, at the start of Phase I composting, the materials were turned and mixed and stacked with the aid of a wire netting frame, 1×1×1 metre, under an open shelter. This small experimental stack was subsequently turned and mixed on days 3, 6 and 9 and watered when necessary. On day 10, at the end of Phase I, the compost transferred to wooden trays (internal dimensions 800×1400×200 mm) and moved into a room in a phytotron for Phase II composting. As a ready supply of steam was not available the air temperature was raised by means of electrical heaters to 40 °C while a high relative air humidity was maintained with the aid of a motorized humidifier. At the end of this stage the compost was allowed to cool down after which it was spawned at a concentration of 400 g grain spawn per square metre of bed area. The variety of mushroom used was the "pure white" A32 commonly grown commercially in South Africa.

TABLE 1.

Relative proportions (approximate volume) of ingredients used in preparing stack composts.

Substrate	Proportion of ingredients
Wheat straw	50
Horse manure (stable bedding)	35
Chicken manure	10
Gypsum (hydrated calcium sulphate)	4
Superphosphate	1

The spawn was allowed to colonize the compost over a period of 10 days at a room temperature of 25 °C and a relative air humidity of 95 %. The compost was then "cased", i.e. it was covered with a layer of casing soil to a depth of 25–35 mm. Casing soil consists of equal parts of ground peat and limestone. The cased trays were moved to the growth room in a phytotron where they were incubated in darkness at a temperature of 18 °C and a relative air humidity of 85 % up till the stage that the first flush of sporophores appeared (Fig. 1), usually around day 46.

Temperature fluctuations in the compost, especially during Phases I and II, were measured by inserting a long thermometer vertically into the centre of the stack to a depth of 400 mm in the case of Phase I and to a depth of 100 mm in the Phase II compost. Readings were taken daily (Table 2). The pH was measured regularly using a Beckman pH meter with a glass electrode. About 25 g compost was soaked in 100 mℓ of distilled water (pH 5,3) for 1 hour prior to pH determinations (Table 2).

Sampling

Previous investigators have pointed out the problems associated with sampling of composting materials (Lambert, 1941; Hayes, 1968). To minimise errors which could arise from sampling from different zones in the stack during Phase I, all samples were composite samples composed of material taken at regular depth intervals from the surface of the stack to a point 460 mm below the surface at the centre of the compost stack. This area is considered by Lambert (1941) to be microbiologically the most active. Samples taken during Phase II and later stages of cultivation were mixed subsamples of compost from all regions of the compost.

Thermophilic fungi

Three methods were employed to study the thermophilic fungal flora and to follow the patterns of succession. In one method compost pieces were cut or broken into small pieces and placed in sterile large Petri dishes that had previously been lined with several layers of paper towelling moistened with distilled water and autoclaved. These moist chambers containing the organic substrates were

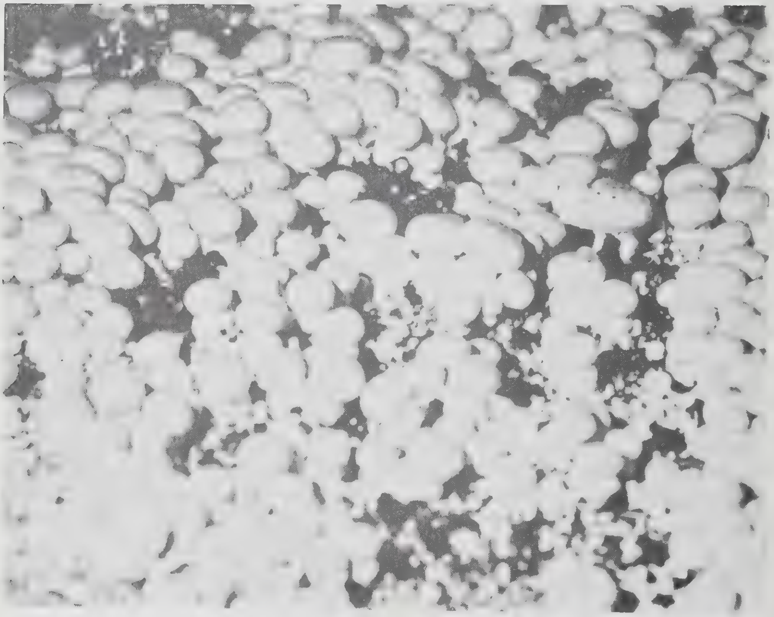

FIG. 1
The first flush of sporophores after about 47 days.

incubated at 53 °C for periods of up to three weeks to provide enrichment conditions allowing the growth of thermophiles. From the third day of incubation the gross cultures were examined with a high power stereoscopic dissecting microscope. Conidia, mycelial fragments or fruiting bodies that could be detected were aseptically transferred to agar plates. These isolation agar plates were inverted, placed in polyethylene bags, and incubated at 53 °C until growth was well established after which the plates were kept at 40 °C. The medium used was Yeast Starch agar (Yp Ss of Emerson, 1941) to which the antibiotic Albamycin (sodium novobiocin) was added at a concentration of 125 mg/ℓ. This antibiotic is thermostable and could be incorporated in the medium before sterilisation. The relatively high level at which the antibacterial agent was used was necessary because thermophilic bacteria were very troublesome at the high incubation temperatures used in these experiments.

In the second method the same procedures were followed as previously described (Eicker, 1972). In brief, the method consists of mixing pulverized pieces of compost directly with molten agar cooled to about 50 °C and pouring plates. In this instance Yeast Glucose agar (Cooney & Emerson, 1964) was used. The same incubation temperature and isolation technique as in the first method were used.

The third method was a modified dilution plate technique devised by Menzies (1957) in which compost suspensions were measured out with a 1 mℓ dipper which prevented larger and heavier particles settling out and being lost as might have occurred with a pipette. About 5 g fresh weight of compost was accurately weighed out and placed in 250 mℓ of sterile distilled water in a 500 mℓ Erlenmeyer flask. This was shaken mechanically for 30 minutes to disperse all materials. A dilution series was prepared from this primary suspension and the degree of the eventual dilution depended on the expected number of viable propagules previously experimentally determined for each stage of composting.

The final dilution factor varied from 1:500 to 1:500 000. One of these dilutions usually gave the optimum of 10–30 colonies per plate. Czapek Dox agar with 0,5 % Difco Yeast extract, rose bengal (1:3 000) and Albamycin (125 mg/ℓ) was used. Ten plates were prepared from each dilution and incubated at 53 °C. The plates were examined after 4 days, the colonies counted, the fungi isolated and the frequency of occurrence (Sewell, 1959) of the different taxonomic entities of thermophilic fungi determined.

The temperature-growth relations of the isolated fungi were determined by growing them in triplicate on Yp Ss and Yeast Glucose agar media. The diameter of the colony was determined daily and visual observations of the degree of sporulation were made after 5 days of incubation at various temperatures.

RESULTS

The results expressed in Tables 2 and 3 and Figures 1 to 6 are based on data obtained from four experiments each comprising the entire 46 day cycle of mushroom cultivation. More than 400 isolates were obtained using the three isolation methods and these were tested according to criteria for thermophily (Cooney and Emerson, 1964). Ten thermophilic species were identified (Table 3). *Aspergillus fumigatus* was also included amongst these for reasons already given (Eicker, 1972). *Mucor miehei* and *Talaromyces duponti* were isolated by the direct plating technique only while *Malbranchea pulchella* occurred only on pieces of compost that were incubated at 53 °C in a moist chamber. The latter three species were very rare and were isolated once or a very few times only. The remaining 7 thermophiles were much commoner and were readily recovered by all three methods used in this investigation. The temperature-growth relationships of all the isolates showed close agreement with those studied by Cooney and Emerson (1964).

During Phase I the temperature of the stacked composting material reached a peak of about 73 °C on day 4 (Table 2, Figs. 2–7) and then gradually decreased to

TABLE 2
Composting schedule, temperature and pH of the compost.

Days of composting	Composting schedule	Compost temperature	pH	Air temperature
0	Phase I	23,5	8,48	ambient
1		44,0	8,12	
2		62,5	7,97	
3	First turn	67,0	7,94	
4		73,0	7,78	
5		71,0	7,73	
6	Second turn	71,5	7,68	
7		68,0	7,61	
8		61,5	7,40	
9	Third turn	54,5	7,18	
10		49,5	7,10	
11	Phase II	33,5	6,98	40,0
12		41,0		40,0
13		42,5		40,0
14		47,0	6,98	40,0
15		54,0		40,0
16		54,5		40,0
17		53,5	6,93	40,0
18		46,0		40,0
19	Cooling down	32,5		35,0
20		27,0		28,0
21	Spawned	26,5	7,0	25,0
22–30	Spawn run	25,0	6,93	25,0
31	Casing applied	18,0	6,63	18,0
32–46	Growth room	18,0	6,62	18,0

below 50 °C by day 10. High temperatures were maintained for 5 to 7 days and the temperature curve shows close agreement with that of grass cutting compost (Webley, 1947) and wheat straw compost (Chang and Hudson, 1967). Phase II temperatures were lower than those of Phase I and reached a maximum of 54,5 °C at day 16. After cooling down at the end of this stage the compost temperatures closely followed the temperature of the air.

TABLE 3

Thermophilic fungi isolated from mushroom compost using three isolation techniques. The temperature range for growth, determined experimentally, is also given.

Species	Temperature range	Methods of isolation		
		Moist chamber	Direct plating	Dilution plate
Aspergillus fumigatus Fresenius . .	15–60 °C	+	+	+
Chaetomium thermophile var. *dissitum* Cooney & Emerson	27–58 °C	+	+	+
Humicola grisea var. *thermoidea* Cooney & Emerson	24–56 °C	+	+	+
Humicola insolens Cooney & Emerson	23–55 °C	+	+	+
Humicola lanunginosa (Griffon & Maublanc) Bunce	30–60 °C	+	+	+
Malbranchea pulchella var. *sulfurea* (Miehe) Cooney & Emerson .	27–56 °C	+		
Mucor miehei Cooney & Emerson	25–55 °C		+	
Mucor pusillus Lindt	20–55 °C	+	+	+
Talaromyces (Penicillium) duponti (Griffon & Maublanc) emend. Emerson	28–58 °C		+	
Torula thermophila Cooney & Emerson	23–58 °C	+	+	+

The initial pH of the compost was usually above 8. During Phase I the pH dropped to about neutrality where it remained until spawning. After the establishment of the mushroom mycelium there was a gradual but slight further decrease in the pH of about 0,4 units (Table 2).

The occurrence and patterns of succession of the various species of thermophilic fungi encountered in this investigation are discussed separately.

Aspergillus fumigatus Fresenius

The sixty odd isolates of *Aspergillus* fell within the range of *A. fumigatus* (Raper & Fennell, 1965). This organism is extremely plastic and subject to a high mutation rate (Evans, 1971) and this could account for the wide range of morphological and cultural variations. This characteristic is probably also responsible for the adaptability of *A. fumigatus* and the universal appearance of this fungus on a wide variety of substrates. Throughout the period of observation it was present in the mushroom compost in low numbers with a percentage frequency of occurrence of 15 % or less (Fig. 2). It tended to increase in numbers towards the end of cultivation. Fergus (1964) also noted that it was quite prominent at the end of Phase II of the composting process.

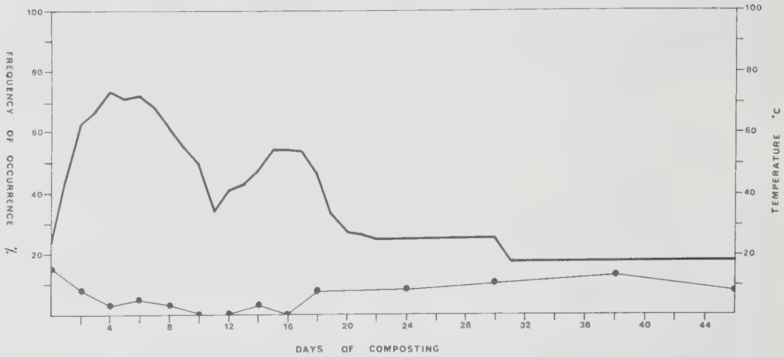

FIG. 2.

Frequency of occurrence of *Aspergillus fumigatus*. In the graph frequency of occurrence the fungal species is represented by ●—●—● while the second curve represents the temperature.

Chaetomium thermophile var. *dissitum* Cooney & Emerson

This fungus formed easily recognisable perithecia on incubated pieces of compost and also on the media used in the other isolation methods. Although Emerson and Cooney's separation of the varieties of the thermophilic *C. thermophile* is rather arbitrary, isolates encountered in this investigation could be accommodated in their var. *dissitum*. This fungus is apparently quite common in composting materials and I have isolated it from several such habitats in this country (Eicker, 1972). Fergus (1964) reported that *C. thermophile* is quite common in mushroom compost during peak heating, but he did not indicate which variety he isolated. The same is also the case with Chang and Hudson (1967) who reported the occurrence of *C. thermophile* on wheat straw compost.

This mould grew very actively during the early stages of composting (Fig. 3), but its numbers decreased during Phase II and had disappeared by the end of the spawn run. Kane and Mullins (1973) have shown that this fungus has a very high cellulolytic ability and its disappearance during spawn run could be attributed to substrate competition with *A. bisporus*.

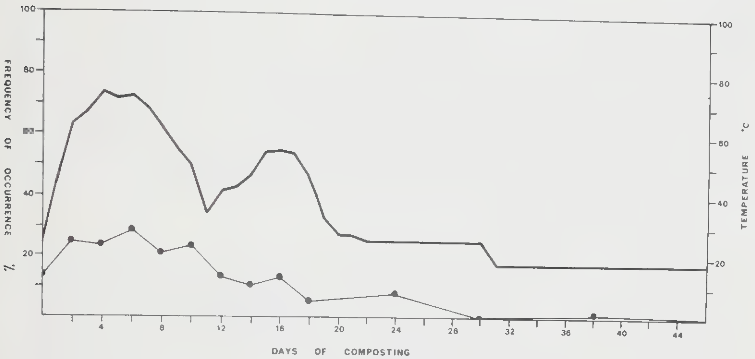

FIG. 3.
Frequency of occurrence of *Chaetomium thermophile* var. *dissitum.* For legend see Fig. 2.

Humicola grisea var. *thermoidea* Cooney & Emerson

The globose to oval, dark brown aleurioconidia which formed on unbranched conidiophores gave this fungus a very characteristic appearance. All isolates agreed well with the species and variety descriptions given by Cooney and Emerson (1964). Occasional intercalary chlamydospores were also produced in substrate hyphae but no phialospores were detected in any of the isolates. The temperature relationships of this thermophile agree well with those given by the original authors. Its occurrence in the compost is high during the thermogenetic stages of composting and its activity correlates very well with the temperature of the substrate (Fig. 4). Two optima are evident in its frequency of occurrence and these correspond with the maximum temperatures recorded during Phase I and

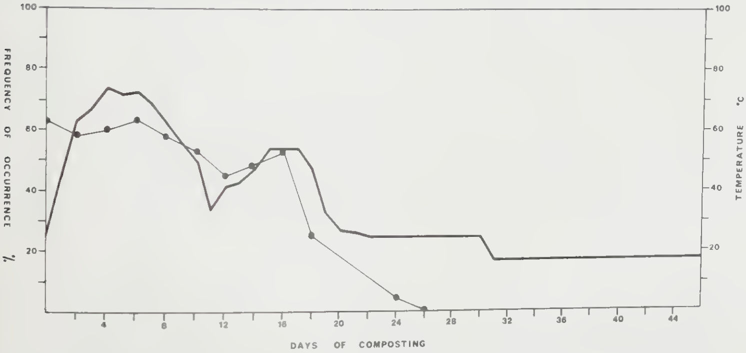

FIG. 4
Frequency of occurrence of *Humicola grisea* var. *thermoidea.* For legend see Fig. 2.

Phase II respectively. At the end of Phase II this fungus can no longer be detected in the substrate.

Fergus (1964) recorded this species from the surface of mushroom compost during peak heating. Hensen (1957) isolated it from horse manure but Chang and Hudson (1967) could not isolate it from wheat straw compost. The possible origin of *H. grisea* might therefore be sought in manure, seeing also that the original habitat of the type material was elephant dung (Cooney & Emerson, 1964).

Humicola insolens Cooney & Emerson

This species, which was also very common in the mushroom compost, could easily be distinguished from the other thermophilic *Humicola* species by its abundant production of light brown, usually globose to oval aleurioconidia, formed mostly in intercalary positions in chains. They also occurred in short lateral chains on lateral aleuriophores. Although this fungus was very abundant during the early stages of composting and showed the same two optima as *H. grisea* var. *thermoidea*, it differed from the latter in that it persisted throughout the entire period of cultivation (Fig. 5). This thermophile was particularly active during Phase II, a fact also noted by Fergus (1964) and Chang and Hudson (1967). Bels-Koning, *et al.* (1962) recorded this fungus, as *Humicola nigrescens* Omvik, towards the end of composting. Hayes (1968) indicated that *H. insolens* and *H. grisea* var. *thermoidea* were the dominant members of the mycoflora at day 3 and subsequently during Phase I and Phase II of the mushroom compost studied by him.

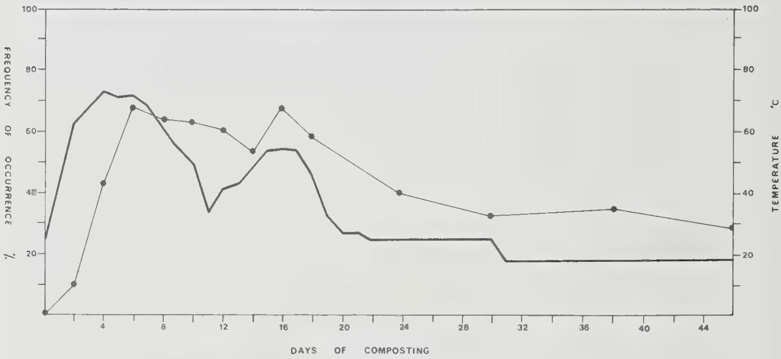

Fig. 5

Frequency of occurrence of *Humicola insolens*. For legend see Fig. 2.

Humicola lanunginosa (Griffen & Maublanc) Bunce

H. lanunginosa was not present at the beginning of the composting cycle. It appeared from the second to the third day and reached a maximum by day 6 of

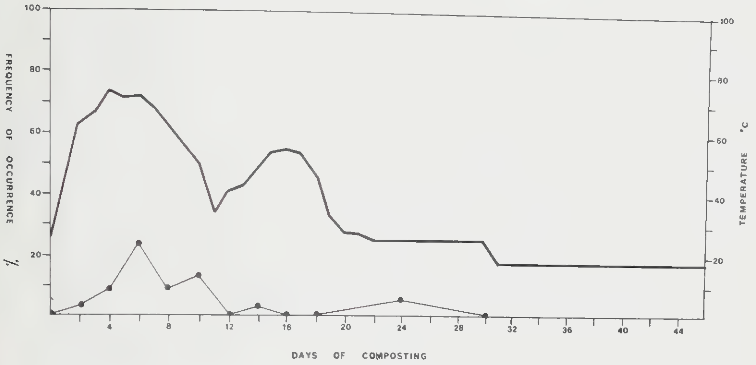

FIG. 6
Frequency of occurrence of *Humicola lanunginosa*. For legend see Fig. 2.

Phase I and then quickly disappeared again (Fig. 6). Fergus (1964) recorded this species only once from the surface of Phase II compost. Chang and Hudson (1967) made records of this fungus before, during and after the heating phase of wheat straw compost. In their investigation of the mycoflora of moist hay undergoing thermogenesis in Dewar flasks, Festenstein *et al.* (1965) found that *H. lanunginosa* was very abundant, producing up to 14 million spores/g dry weight, in the middle layers of the substrate. I have also found this fungus to be extremely common in this country, recording it from 70 % of the substrates which were previously investigated (Eicker, 1972). The taxonomic confusion surrounding *H. lanunginosa* was clarified to some extent by Bunce (1961) and Cooney and Emerson (1964) who considered the genera *Thermomyces*, *Monotospora* and *Acremoniella* to be synonyms for *Humicola*. In his presentation of Dematiaceous Hyphomycetes Ellis (1971), however, follows Apinis (1963) in naming this fungus *Thermomyces lanunginosus* Tsiklinsky.

Malbranchea pulchella var. *sulfurea* (Miehe) Cooney & Emerson

This beautiful thermophilic mould was isolated only three times during this investigation. Colonies developed on pieces of composting material which were collected during the early stages of Phase I and which were incubated at elevated temperature in a moist chamber.

Mucor miehei Cooney & Emerson

Although Sarbhoy (1968) is of the opinion that both the known thermophilic mucors, *M. pusillus* Lindt and *M. miehei* are synonyms, an isolate from early Phase I compost with the direct plating technique, agreed so closely to Cooney and Emerson's fungus that it was designated as *M. miehei*.

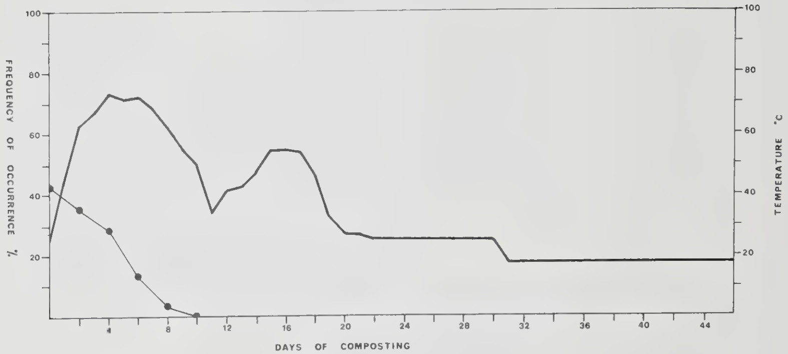

Fig. 7
Frequency of occurrence of *Mucor pusillus.* For legend see Fig. 2.

Mucor pusillus Lindt

This fungus was quite common on substrates used for composting and it had a fairly high frequency of occurrence at the onset of composting. Its numbers rapidly declined and by day 9 it was no longer detectable (Fig. 7). It was recorded by all three methods. As pointed out by Chang and Hudson (1967) the successional pattern of this phycomycetous species is typical of Garrett's (1951) ''Saprophytic sugar fungi''. Fergus (1964) recorded it only once from a surface sample of Phase II mushroom compost.

Talaromyces (Penicillium) duponti (Griffen & Maublanc) emend Emerson

This thermophilic representative of the Eurotiales was isolated on three occasions by incorporating pieces of compost from late Phase I composting in Yeast Glucose agar and incubating the plates at 53 °C. Chang and Hudson (1967) recorded this fungus from composting wheat straw and Fergus (1964) isolated it from Pennsylvania mushroom compost.

Torula thermophila Cooney & Emerson

Cooney and Emerson (1964), Hayes (1968) and Cailleux (1973) reported the occurrence of this fungus in mushroom compost. In this investigation all three methods employed yielded isolates of this species. Its occurrence was, however, low and confined to Phase II composting with isolation records on days 11, 12 and 15.

DISCUSSION

Composting is a dynamic process with a carefully ordered succession of populations. Hayes (1968), Fordyce (1970) and some other investigators have indicated that a definite ecological cycle exists and that populations of micro-organisms show a clear and changing pattern. These authors have shown that the early increases and late decreases of temperature during Phase I are parallelled by similar changes in numbers of micro-organisms. This is also true for Phase II which is particularly dominated by thermophilic organisms. Mushroom compost lends itself to the study of microbial ecology, particularly that of thermophiles. The controlled conditions under which the mushroom is grown and the relatively short time required to complete the ecological cycle are favourable factors. There are many practical difficulties in providing a valid qualitative and quantitative estimate of viable micro-organisms. The dilution plate method was adopted in this investigation. Although populations of thermophilic fungi obtained by this method are of doubtful value in absolute terms (Meiklejohn, 1957; Warcup, 1960) it is the most practical and meaningful method for the general study of fungal activity in composts (Hayes, 1968).

With the dilution plate method, in conjunction with two other methods, it was possible to make a comprehensive survey of the thermophilic fungi in mushroom compost and to correlate their occurrence with the temperature changes of the substrate. The activity of these fungi was almost exclusively confined to the heating phases of the compost. The only two fungi which persisted throughout the whole cultivation cycle were *Aspergillus fumigatus* and *Humicola insolens*. It is also clear that many of the thermophiles, such as *Malbranchea pulchella* var. *sulfurea*, *Mucor miehei* and *M. pusillus*, which were present at the onset of composting did not survive long, since they were probably eliminated by the very high temperatures of Phase I.

Dickinson and Pugh (1974) state that well-insulated compost heaps have a considerable heat production which can lead to temperatures in the range of 80–90 °C. Experimental data, however, indicate that at such temperatures the reaction rate of micro-organisms is low. Optimum activity is obtained at temperatures of about 55 °C at which the thermophilic fungi are exerting their maximum influence. The two *Humicola* species, *H. grisia* var. *thermoidea* and *H. insolens*, as well as *Chaetomium thermophile* var. *dissitum* and *Torula thermophila* are the main representatives of this group of active fungi.

The aim of mushroom composting is to produce, largely by the activity of micro-organisms, a substrate which is suitable for the mycelial growth of *Agaricus bisporus*. In the preparation of composts for commercial growing it is essential that all food requirements of the mushroom, which is especially demanding (Smith & Hayes, 1972), are made available by a thorough and carefully controlled composting procedure. This is a demanding and complicated process when variable and bulky materials such as animal manures and other organic substrates are used. Many attempts have been made to accelerate the fermentation by careful preparation of ingredients, mechanical breakdown of vegetable matter (Laborde & Delmas, 1969), carbohydrate supplements (Hayes, 1968) and by inoculating the compost with suitable thermophilic fungi (Pope, *et al.*, 1962). The application of these and other methods demands a precise knowledge of the nature and activity of the micro-organisms active in composting. It is hoped that this investigation has contributed to this much needed information.

ACKNOWLEDGEMENTS

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Jl S. Afr. Bot. 43 (3): 209–211 (1977)

Short Communication

A NOTE ON THE SEED-COAT STRUCTURE OF *ERYTHRINA CAFFRA* THUNB.

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The seeds of *Erythrina caffra* are bright coral red and more or less kidney-shaped. On the convex surface is a linear, black scar, the hilum. Germination studies revealed that the seed-coat is impermeable to both water and oxygen (Small, McNaughton and Greef, unpublished data). As it was suggested that the palisade layers of the testa are responsible for impermeability properties of leguminous seeds (Esau, 1960; Villiers, 1972), the seed-coat structure of *E. caffra* was investigated.

The following layers, all derivatives of the outer integument of the ovule, could be distinguished in the seed-coat of *E. caffra.*

(a) On the outside is the palisade layer which consists of a single layer of radially elongated macrosclereids (Fig. 1).

(b) Then follows a region of more or less columnar cells, which are slightly constricted about the middle. One layer of these, the hour-glass cells, fits tightly against the palisade cells, but towards the equator of the seed they are more loosely arranged.

(c) The two innermost layers consist of obliterated parenchyma (Fig. 1).

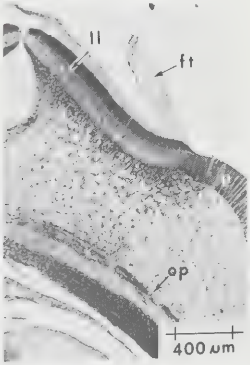

Fig. 1

Transverse section through seed-coat of *E. caffra* (ft—funicular tissue; ll—light line; op—obliterated parenchyma; p—palisade).

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At the hilar region the structure is more complicated. Above the palisade, on either side of the hilar fissure, is a parenchymatous layer and a layer of radially elongated cells. Both these are of funicular origin (Fig. 1).

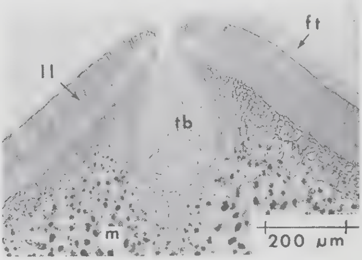

Fig. 2
Transverse section through hilar region (ft—funicular tissue; ll—light line; m—mesophyll; tb—tracheid bar).

Subtending the hilar fissure is a compact group of tracheids with large pits. This is known as the tracheid bar (Fig. 2). Surrounding this are four to five layers of cells, the walls of which are pitted and thickened, although not lignified. Then follows a broad band of aerenchymatous tissue, often called mesophyll. The cells are extensively branched and some are filled with a reddish-brown deposit (Fig. 2). Separating the mesophyll from the cotyledons are two layers of obliterated parenchyma (Fig. 1).

The occurrence of two palisade layers in the hilar region has been reported for several legumes (Hyde, 1954; Chowdhury and Buth, 1970), including *Erythrina variegata* (Maranon and Santos, 1932). However, in *E. caffra*, although the hilar palisade appears to resemble two layers of cells, it is in fact uniseriate.

In this single-layered palisade of the hilar region each cell is differentiated into an inner and an outer part with a difference in diameter of the cell lumen. This optical effect has been labelled light-line (Coe and Martin, 1920; Hamly, 1932,

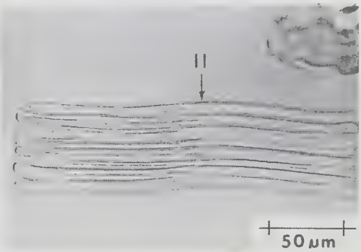

Fig. 3
Maceration of palisade layer showing macrosclereids with light line (ll—light line).

1934; Cavazza, 1950) or *linea lucida* (Corner, 1951) and occurs only in the hilar region (Fig. 2 and 3). That only one palisade occurs is substantiated by the following points. There are no nuclei in the outer part. In those species where a true counter-palisade is found, a cuticle separates the two palisade layers, but in *E. caffra* the cuticle of the would-be counter-palisade is continuous with that of the palisade (Fig. 1). Macerations reveal the presence of macrosclereids in which the difference in cell lumen simulates a dividing wall (Fig. 3). However, under high power there is no evidence of transverse walls. The outer and inner parts are continuous (Fig. 4).

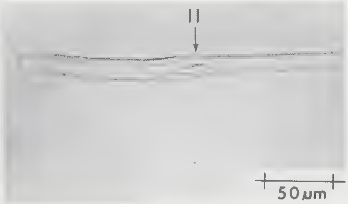

Fig. 4
A single macrosclereid from palisade maceration (11—light line).

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PHYSIOLOGICAL STUDIES ON THE GERMINATION OF *ERYTHRINA CAFFRA* THUNB. SEEDS

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ABSTRACT

Dormancy of *Erythrina caffra* seeds was overcome by mechanical abrasion, piercing of the hilum or sulphuric acid scarification. Heat treatments were ineffective.

Germination was not affected by light. The optimum temperature for germination was 30 °C.

The testa restricted oxygen uptake. The very high RQ-values of germinating seeds was reduced by testa removal or increased oxygen tension. Acid scarified seeds had higher germination rates than abraded or hilum pierced seeds. This was attributed mainly to an increased oxygen permeability of the testa.

UITTREKSEL

ONTKIEMINGS FISIOLOGIE VAN *ERYTHRINA CAFFRA* THUNB. SAAD

Die rustoestand van *Erythrina caffra* saad is opgehef deur die saadhuid te skuur, 'n gaatjie in die hilum te steek of deur swaelsuurweking. Hitte behandelings was oneffektief.

Ontkieming is nie deur lig beïnvloed nie. Die optimum ontkiemingstemperatuur was 30 °C.

Die testa beperk suurstofopname. Die hoë RK-waardes van ontkiemende saad kon deur testaverwydering of verhoogde suurstofspanning, verlaag word. Suur behandelde saad het vinniger ontkiem as geskuurde of hilum deurboorde saad. Dit is hoofsaaklik daaraan toegeskryf dat swaelsuur die deurlaatbaarheid van die testa vir suurstof verhoog.

INTRODUCTION

Seeds of *Erythrina caffra* fail to germinate when incubated under conditions normally favourable for germination. The dormancy may be expected to be due to impermeability of the seed coat to water as this is a common feature of the family Leguminosae (Hamly, 1932; Barton, 1965; Villiers, 1972; Mayer & Poljakoff-Mayber, 1975). Impermeability of the seed coat to water in this family has been ascribed to the cells of the palisade layer (Esau, 1967; Villiers, 1972). The testa of *Erythrina caffra* has a well defined palisade layer as shown by McNaughton & Robertson (1977).

This investigation describes experiments on the effect of scarification method, heat treatment, light and temperature on germination. Water uptake, seed respiration and the effect of oxygen and nitrogen on germination were also studied in an effort to explain differences in germination rate caused by different scarification methods.

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MATERIAL AND METHODS

Seed material

Seeds were collected from a single tree growing in Nelson Square, Port Elizabeth. Healthy seeds of uniform size, lacking beetle sting and other foreign markings, were selected. These were treated with phostoxin (Bayer Agro-Chem) to prevent accumulation of and attack by beetles, aerated briefly and stored in stoppered glass jars in the laboratory. The phostoxin treatment had no effect on subsequent germination.

Germination

Depending on the experiment, seeds were germinated on three layers of filter paper in 90 mm glass petri dishes, or in 500 mℓ conical flasks or in washed river sand. Twenty-five seeds were used per replicate. Petri dishes contained 20 mℓ of distilled water and conical flasks 25 mℓ. These water levels were found in preliminary experiments to be optimal for germination. The sand was kept moist. Petri dishes were oven sterilized; conical flasks, sand and water were autoclaved.

Seeds were surface sterilized by immersion in 70 % ethyl alcohol for one minute followed by 4 minutes in 0,1 % $HgCl_2$ and subsequently rinsed thoroughly with sterile, distilled water. This method was found to be more effective than hypochlorite sterilization. In all cases seeds were placed at random in the germination medium, i.e. not orientated in a particular way.

Germination tests were performed in Controlled Environments Model E7H growth cabinets maintained at 80 % RH. Treatments were replicated 4 times. Radicle emergence was used as the index of germination.

Respiration

Oxygen uptake and carbon dioxide evolution by germinating seeds were determined manometrically using the ''direct method'' of Warburg (Umbreit, Burris & Stauffer, 1972) in a Gilson differential respirometer equipped with an all glass submarine volumometer system. Measurements were made at 25 °C on 8 replicates of 5 seeds per respiration flask. On completion of gas exchange measurements, seeds were oven dried at 105 °C for 24 hours for dry mass determinations.

RESULTS

Effect of scarification and heat treatment on germination

The following treatments were applied

1. Control—no treatment
2. Mechanical abrasion—seeds were rubbed on one side with sand paper to expose approximately 4 mm² of cotyledon

3. Acid scarification—seeds were soaked for 30 or 120 minutes in concentrated sulphuric acid and then washed in running tap water
4. Hilum pierced—a single hole was pierced through the centre of the hilum with a dissecting needle
5. Dry heat—seeds were placed in an oven at 90 °C for 15 or 30 minutes
6. Hot water—seeds were immersed in hot water (80 °C and 100 °C) for 10 seconds or 5 minutes.

After treatment all seeds were surface sterilized and incubated in the dark at 25 °C in petri dishes. The number of swollen and germinated seeds were recorded after seven days (Table 1).

The highest percentages of swollen and germinated seeds were obtained after mechanical abrasion, acid scarification for 120 minutes and hilum piercing. Although some of the heat treatments did cause an appreciable number of seeds to swell, they were extremely detrimental to germination.

A small number of control seeds germinated. On closer inspection it was found that these seeds had minute holes in their seed coats. It was later confirmed that a small beetle *(Bruchidius* species) was responsible for puncturing and parasitizing *Erythrina* seeds.

Effect of light and temperature on germination of 120 minute acid scarified and mechanically abraded seeds

Seeds were incubated in petri dishes in the light and in the dark at 15 °, 20 °, 25 °, 30 ° and 35 °±0,5 °C. Lighting was obtained from fluorescent tubes at an intensity of approximately 3 800 lux. The dark treatment was obtained by wrapping petri dishes in one layer of aluminium foil. Germination counts of dark-treated seeds were performed under "safe" green light.

Similar germination counts were obtained in the light and in the dark. No interaction between light and seed coat treatment, temperature and seed coat treatment, or between light and temperature was observed. However, temperature markedly affected germination. The optimum temperature for germination was found to be 30 °C. This is shown in Fig. 1 in which the mean germination counts after 48 hours of incubation are plotted.

During this, and subsequent experiments it was noted that acid treated seeds had a higher germination rate than abraded seeds. The slower germination of the latter was not simply a function of abraded area since seeds sandpapered to expose approximately 1 mm^2, 4 mm^2 and 12 mm^2 had similar germination rates. The "acid effect" was therefore investigated further.

Effect of scarification method on water uptake

To test whether the stimulatory effect of acid scarification was due to an increased water uptake, the moisture content of abraded, acid scarified (120

TABLE 1

Effect of scarification and heat on swelling and germination after 7 days incubation (means of 4 replicates ± SE).

	TREATMENTS										
				H_2SO_4		Dry heat 90 °C		Hot water 80 °C		Hot water 100 °C	
	Control	Mech Abraded	Hilum pierced	30 min	120 min	15 min	30 min	10 sec	5 min	10 sec	5 min
% Swollen	4±1,6	100±0	94,6±5,3	37±3,4	99±1,0	37±9,4	63±3,4	10±3,4	33±5,2	8±1,6	67±7,7
% Germinated	4±1,6	92±8	94,6±5,3	30±4,7	95±2,5	0	0	10±3,4	9±3,8	6±2,0	0

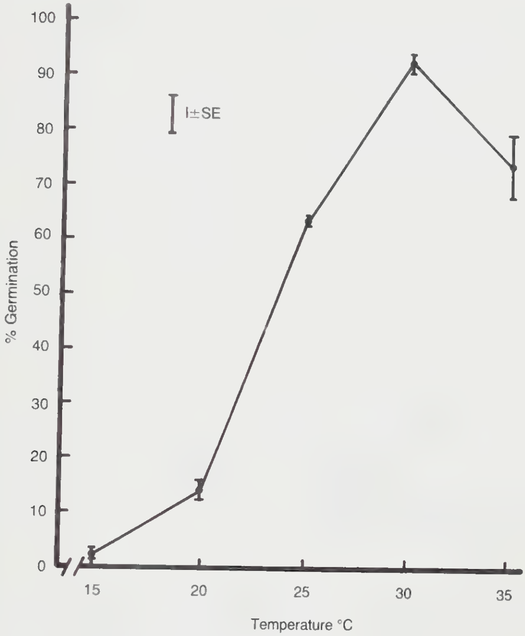

FIG. 1.
Effect of temperature on germination after 48 hours incubation.

minutes) and hilum pierced seeds was compared over a 96 hour period of incubation. Three germination techniques were used, viz. germination in sand, in petri dishes and in conical flasks stoppered with cotton wool.

Incubation was at 25 °C in the dark. After various periods three replicates of 25 seeds each were removed for germination counts and moisture determination. Moisture content was calculated on a fresh weight basis after oven drying at 105 °C for 24 hours.

Similar results were obtained with the different germination techniques. The effect of seed coat treatment on rate of germination and moisture content of seeds germinated in petri dishes is shown in Fig. 2.

As previously found, sulphuric acid scarification resulted in greater germination rates than either mechanical abrasion or hilum piercing. Water uptake, however, was slower after acid scarification. These results suggest that the beneficial effect of sulphuric acid scarification was not caused by increased water uptake.

It was noted that water uptake (judged by swelling pattern) of acid scarified

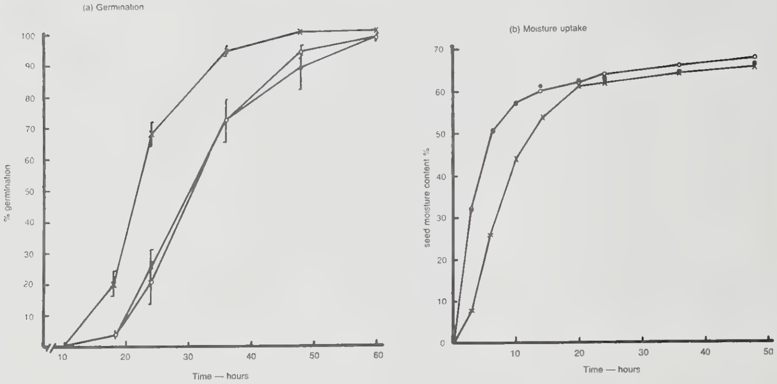

FIG. 2.
Effect of seed coat treatment on germination and moisture uptake (X, H_2SO_4 scarified; ●, Hilum pierced; ○, Abraded).

and hilum pierced seeds proceeded from the hilum area whereas swelling of abraded seeds proceeded from the abraded area.

Respiration studies

Although the impermeability of the seed coat to water is undoubtedly the cause of dormancy in *E. caffra* it was thought possible that the different seed coat treatments could affect oxygen permeability differently and thus cause differences in germination rate. It is known that, apart from affecting water uptake, scarification may induce other changes also, such as permeability to gases, changes in sensitivity to light or temperature and possibly even destruction or removal of inhibitory substances (Mayer and Poljakoff-Mayber, 1975).

To test whether the seed coat restricted gaseous exchange, the respiration of abraded seeds which had imbibed water for 18 hours was measured in air and compared with that of similar seeds allowed to respire in pure oxygen and to that of embryos in air after removal of the testa. The results are shown in Table 2.

TABLE 2
Effect of seed coat removal and oxygen on respiration of seeds after 18 hours imbibition.

Seed Treatment	0_2 uptake $\mu\ell\ g^{-1}\ hr^{-1}$	CO_2 evolution $\mu\ell\ g^{-1}\ hr^{-1}$	RQ
Abraded, respiring in air	10,8±0,2	76,2±4,4	7,06±0,4
Abraded, respiring in oxygen .	50,3±1,7	68,4±1,5	1,36±0,03
Minus seed coats, respiring in air	122,3±11,3	73,2±2,9	0,6±0,02

An increase in oxygen uptake, and drop in RQ-value were observed when seeds respired in pure oxygen or when testas were removed. The greatest effect was caused by testa removal. These results demonstrate that the seed coat, in spite of abrasion in a small area, markedly restricts oxygen uptake.

To test whether acid scarification affects the permeability of the seed coat to oxygen differently to mechanical abrasion, the respiration of seeds was determined after various periods of incubation at 25 °C in conical flasks stoppered with cotton wool.

The results are shown in Fig. 3.

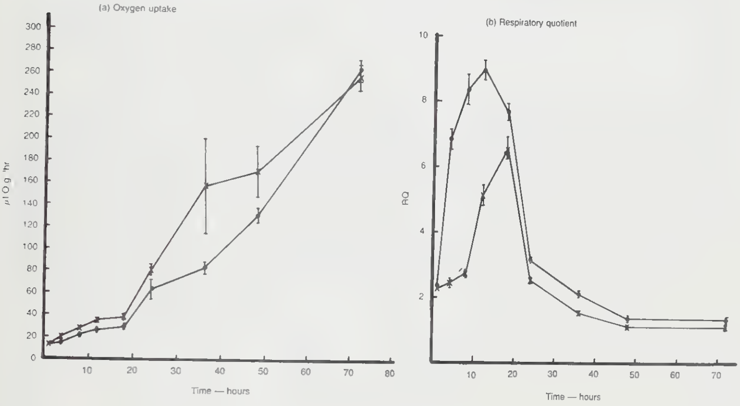

FIG. 3.

Effect of scarification on respiration (● Abraded; X, H_2SO_4 scarified).

Up to about 65 hours after the commencement of imbibition, the rate of oxygen uptake was higher in acid scarified than in abraded seeds. The RQ-values of abraded seeds were initially of a much higher order than that of acid treated seeds.

Effect of oxygen and nitrogen on germination

From the results of the previous experiment it appeared that acid scarified seeds were more permeable to oxygen than abraded seeds. It could therefore be expected that increasing the oxygen partial pressure would reduce differences in germination rate. This hypothesis was tested by germinating acid scarified and abraded seeds in air and in pure oxygen in conical flasks at 25 °C. For air treatment, flasks were stoppered with cotton wool. To obtain the oxygen treatment, flasks were stoppered with vaccine caps through which two hypodermic needles were inserted. High purity oxygen was passed through the flasks at a rate of 500 mℓ per minute for 15 minutes after which the gas flow was stopped. The hypodermic needles were removed after allowing a short period for flask and atmospheric pressure to equilibrate.

In addition, seeds were incubated in nitrogen at atmospheric pressure. This was obtained by repeated evacuation and refilling vaccine capped conical flasks containing seeds, with high purity nitrogen following the method of Umbreit *et al.* (1972).

As found previously, acid treated seeds germinated faster than abraded seeds when incubated in air (Fig. 4). An initially high concentration of oxygen increased the germination rate of abraded seeds but not that of acid scarified seeds. A high nitrogen concentration retarded germination; the effect being similar for both seed coat treatments.

Discussion

The results obtained in this investigation have shown clearly that the dormancy of *E. caffra* seeds is caused by a hard testa impermeable to water. Of the methods

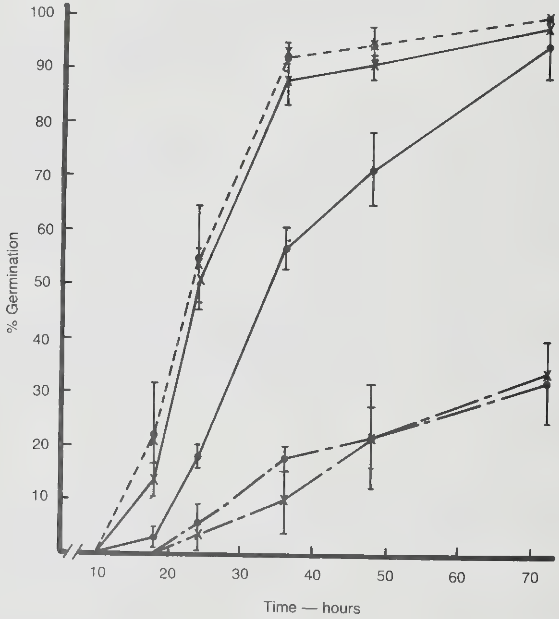

Fig. 4.

Effect of air, oxygen and nitrogen on germination of abraded and acid scarified seeds (● Abraded; X, H_2SO_4 scarified; — Air; – –˙– Oxygen; — — — Nitrogen).

tested, piercing the hilum, mechanical abrasion and sulphuric acid scarification were most effective in causing water uptake and germination. Although only a limited range of heat treatments were used, the results indicate that *E. caffra* is rather sensitive to heat and that this type of treatment is ineffective in promoting germination in this species. This is concluded from the finding that increased extremity of heat treatment caused an increase in percentage swollen seeds but a decrease in germination percentage. Various authors have used heat as a treatment to soften seeds of a number of species (Barton, 1965). Although high germination can be obtained with heat treatment in some cases, (e.g. Gray, 1962) it appears that there is a considerable variation in germination response to heat among legume genera and species (Martin, Miller & Cushura, 1975).

The extreme "hardness" of *E. caffra* seeds poses the question of how these seeds are rendered permeable to water in nature. It is generally assumed that the most common way in which such seeds become permeable in nature is through attack by micro-organisms. Both Barton (1965) and Villiers (1972) state that while bacterial or fungal action is very probably responsible for surface deterioration of seeds, evidence for this is scarce. In the case of *E. caffra* it is possible that a puncturing of the seed coat by a *Bruchidius* species could contribute to dormancy breaking in a small percentage of seeds. If sufficient moisture were available it appears probable that at least some parasitized seeds could germinate before being killed by the developing larvae.

The temperature effects found and the relatively high optimum temperature (30 °C) for germination, correlates with the fact that *E. caffra* inhabits warm subtropical regions. The lack of a light effect on germination is in accord with the behaviour of several legume species (Nakamura, 1962).

Apart from the impermeability of the testa to water it also appeared to restrict oxygen diffusion. Evidence for this was found in the lowered RQ-values when seeds respired in pure oxygen or in air, after removal of testas. Furthermore, an increased oxygen tension increased germination rate. The extremely high RQ-values suggest that fermentation had taken place. This is a common feature of the early stages of germination (Mayer & Poljakoff-Mayber, 1975). The respiratory pattern observed was similar to that found by Spragg & Yemm (1959) for peas although they recorded much lower RQ-values.

Throughout this study it was consistently found that sulphuric acid-scarified seeds germinated at a higher rate than mechanically abraded seeds. This was not due to an increased water uptake. Also, it did not appear to be due to a weakening and thus a decrease of the resistance of the testa to radicle emergence, since the seed coat treatments resulted in equal rates of germination in a high nitrogen atmosphere. Oxygen permeability, however, appeared to have been enhanced by acid treatment. This was seen in the higher rate of oxygen uptake and lower order of RQ-values of acid treated seeds compared to abraded seeds. A decrease in RQ-value would indicate a decrease in fermentative activity. Although the respiratory activity of seeds of both seed coat treatments contained a high component of fermentation during the early germination stages, it is concluded that the stimulatory effect of acid treatment was due to decreased fermentation and thus to an increase in the aerobic component of respiration.

The mode of action of sulphuric acid in scarification is not clear. Burns (1959) showed that sulphuric acid dissolved the counter palisade layer which obstructs the hilar fissure in *Lupinus angustifolius* or eroded pits through the testa. In the present study it was found that the hilar region was affected most, as judged by the swelling pattern of the seeds. Whether the increased oxygen permeability was restricted to this area was not ascertained.

ACKNOWLEDGEMENTS

The beetle, parasitizing *Erythrina* seeds, was identified by Dr J. P. Furstenberg, Department of Zoology, University of Port Elizabeth.

Financial assistance was received from the University of Port Elizabeth and the C.S.I.R., Pretoria.

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Jl S. Afr. Bot. 43 (3): 223–230 (1977)

THE INFLORESCENCE OF *JUBAEOPSIS CAFFRA* BECC.

B. L. Robertson

(Department of Botany, University of Port Elizabeth)

Abstract

Jubaeopsis caffra is monoecious but both sexes occur on the same inflorescence. The inflorescence of this polycarpic, cespitose palm is borne laterally and is initially enclosed within two woody bracts. Male and female flowers occur either separately or, more commonly, together in a triad of one female and two male flowers. Basically the inflorescence is paniculate, with the first order branching being monopodial. Each flower in the ultimate floral unit, i.e. the triad, is subtended by a bracteole, indicating that this unit represents a condensed branching system. It is suggested that the branching in this unit is sympodial and that the triad is a cincinnus.

Uittreksel

DIE BLOEIWYSE VAN *JUBAEOPSIS CAFFRA* BECC.

Jubaeopsis caffra is eenhuisig. Beide geslagte kom egter op een bloeiwyse voor. Die bloeiwyse van hierdie polikarpiese, polvormige palm word lateraal gedra en word aanvanklik deur twee houtagtige skutblare omhul. Manlike en vroulike blomme kom òf enkel òf, meer algemeen, saam in 'n triade van een vroulike en twee manlike blomme voor. Basies is die bloeiwyse 'n blompluim met die eerste orde van vertakking monopodiaal. Elke blom in die uiteindelike blom eenheid d.i. die triade word deur 'n skutblaar gedra wat aandui dat dié eenheid 'n gedronge vertakkingssisteem verteenwoordig. Daar word voorgestel dat dié vertakking simpodiaal is en dat die triade 'n sinsiniese byskerm is.

Introduction

In view of the fact that floral morphology was the most important criterion used by taxonomists for the classification of Angiosperms during the early part of this century, Beccari (1913) described the flowers of *Jubaeopsis caffra* in great detail in his original classification of this species. It would thus be superfluous to present a description of the floral morphology here.

Beccari (1913) did not, however, deal with the morphology of the inflorescence as a whole in any great detail, and in the light of recent publications in respect of palm inflorescences (Tomlinson & Moore, 1968; Tomlinson, 1970) a study of this aspect of *J. caffra* was considered justified.

Material

The material used in this study was obtained from a 43 year old, cultivated *J. caffra* tree growing in St. George's Park, Port Elizabeth and from trees in the *Jubaeopsis* groves along the Mtentu and Msikaba estuaries in Pondoland.

Results and Discussion

Like in all other palms (Tomlinson & Zimmerman, 1966), *J. caffra* passes through three phases during its ontogeny, viz. a juvenile stage of establishment

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growth, an adult phase of vegetative growth and a reproductive phase during which inflorescences, flowers and fruits are produced. It must be noted though that each stem of this cespitose palm passes through these three stages separately and while some trunks of a particular tree will already be in the third phase, the younger suckers might still be in the first or second phase. In the specimen growing in St. George's Park for example, only half of the stems are in fact in the reproductive phase.

The inflorescences are borne laterally (Fig. 1) and develop from buds in the axils of the foliage leaves. In view of the fact that this species is polycarpic and the flowering does not inhibit the vegetative growth, its flowering is pleonanthic.

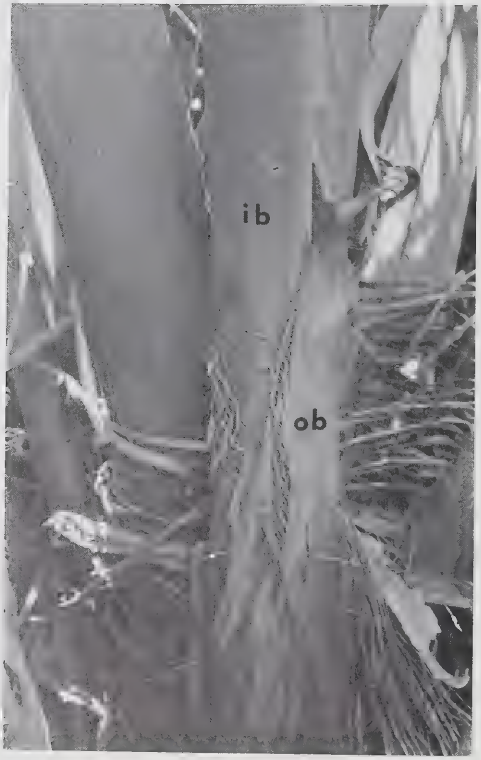


FIG. 1
The two bracts which envelope the inflorescence of *Jubaeopsis caffra*. (ib—inner woody bract; ob—prophyll or outer bract).

Development of the inflorescence is acropetal and the flowering does not inhibit the vegetative growth of the plant as a whole.

Beccari (1913) describes the inflorescence of *J. caffra* as a spadix enclosed in a woody spathe. Corner (1966) also uses this terminology for palm inflorescences in general and equates the inflorescence of the Palmae with the spadix of the Araceae.

Tomlinson (1970) condemns the application of these terms, i.e. ''spadix'' and ''spathe'' to the inflorescences of palms because, apart from the fact that the thickened rachilla of some palms is morphologically incomparable to the fleshy spadix of Araceae, the ultimate unit of the palm inflorescence is very often a series of condensed branches and is not a single spike.

In *J. caffra* the inflorescence is basically paniculate (Fig. 2) consisting of a

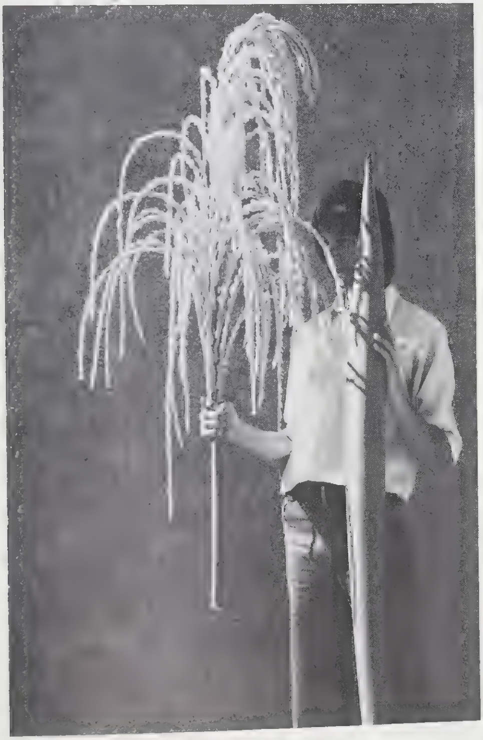


Fig. 2
The open, paniculate inflorescence and outer bract of *J. caffra*

thick central axis which branches monopodially to give rise to the rachillae. (The term ''rachilla'' refers in this article to the visible ultimate axis). These rachillae, which are first order branches, are arranged alternately on the main axis of the inflorescence and exhibit the same phyllotaxy as the foliage leaves on the stem.

J. caffra is monoecious but with both sexes occurring on the same inflorescence. The flowers are all sessile, and occur mostly in triads, i.e. a single central female flower flanked laterally by two male flowers and are borne on the rachillae (Fig. 3). Solitary male flowers however also commonly occur, especially in the distal portions of the rachillae, while more rarely, the extreme proximal flowers are solitary female flowers. Although no female flowers occur in the distal regions of the rachillae themselves, they do occur over the entire length of the inflorescence as a whole. This is best observed after fruit-set (Fig. 4).

As in all other cocosoid palms, the inflorescence of *J. caffra* is initially enclosed within two large bracts (Fig. 1). The fibrous outer bract which is between

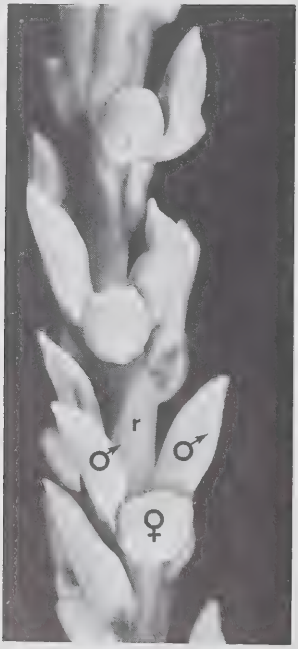


Fig. 3
The ultimate unit of the inflorescence, viz. a triad of two lateral male flowers and a centrally placed female flower (r—rachilla).

300 and 400 millimetres long constitutes the prophyll of the axillary branch, i.e. the inflorescence. It would seem that the primary function of this first bract is to protect the inflorescence until it has emerged from between the leaf sheaths. Thereafter, the prophyll is split as the second bract emerges. This latter bract is very much larger than the prophyll and attains a length of 1,0 to 1,5 metres. Initially the development of the inflorescence appears to be limited to elongation of the main axis, and during the early stages of development the second bract has a sword-like appearance. Once the inflorescence has achieved its maximum length though, the distal section of the second bract swells as the flowers develop. When the flowers are mature, this thick woody bract splits longitudinally and collapses from its erect position to a hanging one and thus exposes the large, cream-coloured inflorescence.

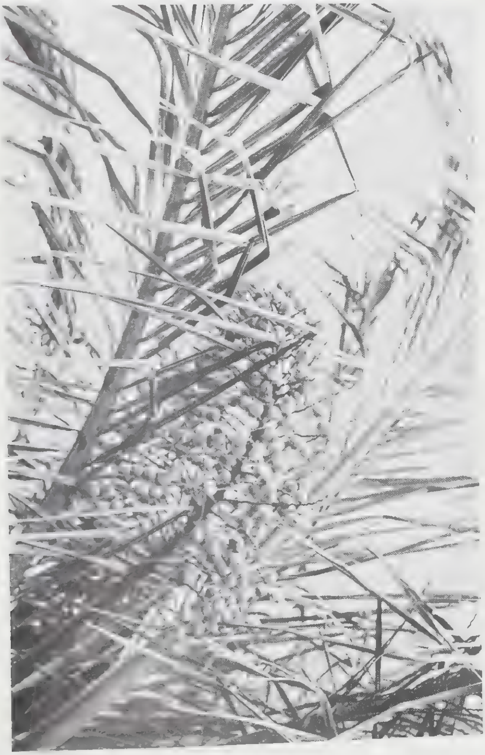


FIG. 4
A bunch of *J. caffra* fruits

Tomlinson (1970) states that in palms generally there is a tendency towards the reduction in the number of bracts in an inflorescence. Correlated with this reduction in number is an increase in size of the bracts. He reports further that in the inflorescences of all cocosoid palms, only two bracts occur, viz. a prophyll and a large, sometimes woody, bract as described above for *J. caffra*.

However, apart from each rachilla in the inflorescence of *J. caffra* being subtended by a bract, albeit a very much reduced structure, each triad and each individual flower in the triad is subtended by a bract and bracteole respectively (Fig. 5A).

The ultimate unit of this inflorescence, is as described above, a triad. This triad consists of a series of highly condensed branches, each subtended by a bracteole and each bearing a single flower, probably terminally (Figs. 5A–C).

Because of the acute congestion of this system it was impossible to establish whether branching is monopodial or sympodial. However, in view of the fact that the ultimate branch units in palm inflorescences are almost invariably cymose, i.e. sympodially branched (Tomlinson, 1970) it seems likely that this might be the case in *J. caffra* as well and that the triad of *J. caffra* is in fact a cincinnus (Fig. 5C).

It appears that the structure of the ultimate floral unit of *J. caffra* is similar to that described by Tomlinson & Moore (1968) for *Nannorrhops ritchiana* which Tomlinson (1970) considers as the basic type of unit for the Palmae in general.

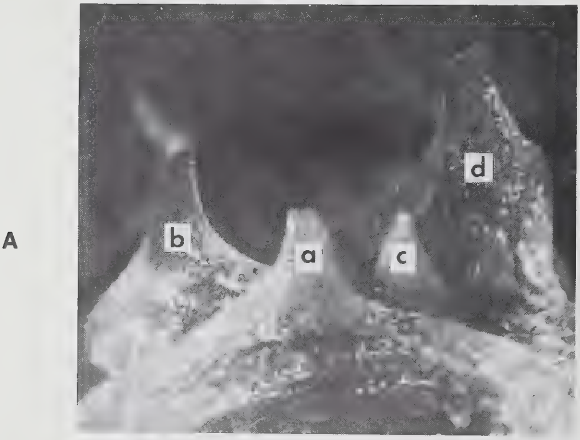
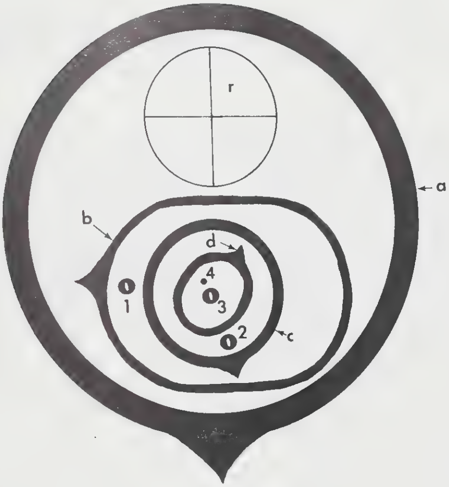


Fig. 5
A. Bract and Bracteoles present in the floral triad of *J. caffra*.
B & C. Schematic representations of the proposed ultimate unit of the inflorescence (1 & 2—lateral male flowers; 3—central female flower; 4—dormant axillary bud; a—bract; b–d—bracteoles; r—rachilla).

B



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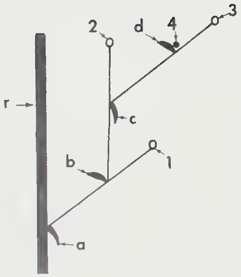

ACKNOWLEDGEMENTS

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BOOK REVIEW

BOTANICAL SYSTEMATICS. An Occasional Series of Monographs. Vol. 1. Series Editor, V. H. Heywood. London, New York, San Francisco: Academic Press, 1976. £24.00.

The publication of a first volume in a new series is always interest-provoking: usually it is also significant, since it is often indicative of progress either in the establishment of a new field of research, or of expansion in an existing field by the incorporation or development of new techniques. The book presently under review is both significant and interesting. In editing it, Professor Heywood has pointed out that with the application of techniques such as scanning electron microscopy and phytochemistry to taxonomic research, there is a need for the publication of extended treatments, often heavily illustrated, and this at a time when scientific journals are increasingly unable to accept lengthy papers. The present new series is the outcome of these two contingencies.

Two papers comprise this first volume. Dr Hanks and Professor Fairbrothers studied the pollen morphology of forty-one of a total of fifty-four known species of *Fagus* and *Nothofagus*. They used scanning techniques and ultrasonification for observation of exine ultrastructure where light microscopy failed to differentiate taxa within the four pollen groups recognized for the two genera. The palynological data obtained were used to produce computerized diagnostic keys, and were also combined with existing morphological, anatomical, cytological and fossil record data in an endeavour to establish a working hypothesis that would reflect the evolutionary relationships of the pollen types. Since, in these genera, the pollen fossil record is extensive and well documented, it was thought that from such relationships, evidence of the migration routes of the genera through time might be deduced. The results are provocative, for they differ from those of other researchers based on other fields of study, and suggest that *Fagus* is more primitive than *Nothofagus*, both genera having developed from prototypes differentiated from a world-wide ancestral type. These conclusions carry considerable interest in the light of modern concepts of continental drift. It would seem that the choice of these genera for the work in hand could not have been bettered at the time it was carried out.

In the second paper Dr Polhill presents the results of a most comprehensive study of Genistae and Related Tribes of the Leguminosae. This paper occupies the major part of the book: surprising were this not so, for vegetative organs, inflorescence, flowers as functional units, their parts, fruits, seeds, anatomy, chromosome numbers, chemical constituents, the definition of tribes and genera, keys to genera and conclusions have been given for upwards of fifty genera.

Dr Polhill's masterly account leads one to the statement that his study must serve as a model that will be difficult to improve upon for many years to come. His knowledge of the plants appears encyclopaedic, yet the facts have been integrated to produce a very readable account of a most interesting group of papilionates, some indigenous to the Mediterranean, others to South Africa (especially the western Cape) others to Australia. Pages of most helpful, excellently executed illustrations show comparisons of calyces, corollas, stamens, stigmas, fruits and seeds. Despite this dissection, the concept of these plants as functional organisms has not been lost: flowers are treated as serving a reproductive purpose in producing seed viable for establishment of the succeeding generation.

Both papers provide a wealth of detailed information that appears extremely accurate and well-indexed: each is supported by a comprehensive bibliography. The book, itself, is pleasing to handle, neat, compact and well produced. It is undoubtedly a specialist publication, fascinating as an illustration of what new techniques have meant to taxonomy; challenging to those undertaking research in comparable fields; not of direct relevance to S. African botany, apart from the work on S. African legumes; not for the layman or the undergraduate except perhaps to show what may be achieved. If other volumes in the series maintain the same standards of research and production, there is much to look forward to.

K. D. GORDON-GRAY

INSTRUCTIONS TO CONTRIBUTORS TO THE JOURNAL OF SOUTH AFRICAN BOTANY

This Journal provides a medium for the publication of the results of botanical research primarily on the flora of Southern Africa, whether systematic, morphological, ecological or otherwise and whether carried out in South Africa or elsewhere. Papers on botanical subjects of special interest and application in South Africa may be included.

Contributions must be original and should not be translations of previously published papers.

Papers must be submitted in final, corrected form. They are accepted for publication on the recommendation of the Editorial Committee.

Authors may be charged expenses for corrections if alterations are excessive.

COPY

Papers should be type-written, double spaced throughout on one side of the paper and with margins of at least 30 mm. Footnotes and elaborate tables should be avoided. Latin binomials should be underlined once to indicate italics. All other marking of copy should be left to the Editor. The original, plus at least one carbon copy, must be submitted.

GENERAL LAY-OUT

Each paper should be headed with a concise informative **title** in capitals with the author's name below. This should be followed by the name of the institution, where the work was carried out, underlined and placed within brackets.

A concise written **abstract** in English and Afrikaans, of not more than 200 words, should precede the text.

The subject matter should be divided into sections under short appropriate **headings** such as: INTRODUCTION, MATERIAL AND METHODS, RESULTS, DISCUSSION, CONCLUSION, ACKNOWLEDGMENTS, etc.

Tables and **illustrations** should be on separate sheets. **Figures** and **graphs** should be in Indian ink on white card or Bristol board. Lettering for figures can be inserted by the printers in which case authors should indicate the desired lettering on the original figure lightly in pencil. The maximum dimensions available for figures are 180 × 120 mm. Line drawings for blocks should be at least twice the size they will be when reduced for publication. All figures should be supplied with a scale. The most suitable method of indicating magnification is a scale line (in SI metric units) incorporated in the figure. Photographs for half-tone reproductions should be on glossy paper, clearly marked on the reverse side (in pencil) to indicate the top. Line drawings and half-tone illustrations are termed figures and should be numbered consecutively. Captions for figures should be typed on a separate sheet of paper.

METRICATION

Authors must use the international (SI) metric system for all measurements, e.g. linear units are to be expressed in metres and millimetres. The use of centimetres is to be avoided. (Metrication pamphlets are obtainable from the South African Bureau of Standards, Private Bag X191, Pretoria, 0001).

When a quotation is incorporated into the text, as in the instance of a locality citation in a taxonomic paper, the original units must be retained as they are of historical and archival importance.

TAXONOMIC PAPERS

Authors must adhere to the International Rules of Botanical Nomenclature. **Abbreviations** and **herbaria** must be cited in accordance with the most recent edition of Index Herbariorum,

Pt 1 (The Herbaria of the World, 5th ed., 1964). When **new species** are described, the exact location of type material must be indicated. When proposing **new combinations** the full citation of the basionym is required. **Indented keys** with numbered couplets are preferred when dealing with a small number of taxa. **Bracket keys** should be used when dealing with a large number of taxa. When citing **synonyms** they should be arranged chronologically into groups of nomenclatural synonyms and these should be arranged chronologically by basionyms. Whenever possible, the types of the basionyms should be cited, e.g.:

Bequaertiodendron magalismontanum (Sond.) Heine & J. H. Hemsley in Kew Bull. **1960:** 307 (1960).
Chrysophyllum magalismontanum Sond. in Linnaea **23:** 72 (1850): Type: Magaliesberg, *Zeyher 1849* (S, holo; BOL!, SAM!).
Zeyherella magalismontana (Sond.) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105:** 37 (1958).
Pouteria magalismontana (Sond.) A. Meeuse in Bothalia **7:** 335 (1960).
Chrysophyllum argyrophyllum Hiern, Cat. Afr. Pl. Welw. **3:** 641 (1898). Syntypes: Angola, *Welwitsch 4827, 4828, 4829* (BM!).
Boivinella argyrophylla (Hiern) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105:** 37 (1958).
Chrysophyllum wilmsii Engl., Mon. Sapot. Afr.: 47 t. 16 (1904). Type: Transvaal, *Wilms 1812* (B†, holo.; K!).
Boivinella wilmsii (Engl.) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105:** 37 (1958).

CITATION OF SPECIMENS

In the interests of uniformity contributors are requested to follow the recommendations of Leistner and Morris (*Ann. Cape prov. Mus.* **12:** 1976) by citing specimens according to the one degree grid system. Distribution data are given separately for each province and are arranged in the following sequences: South West Africa, Botswana, Transvaal, Orange Free State, Swaziland, Natal, Lesotho, Cape. Within each province degree squares are listed in numerical sequence, i.e., from west to east and from north to south. Whenever possible locality records should be given to within a quarter degree square. The collectors' names and numbers are underlined *(printed in italics)* to avoid confusion with the numbers of the degree squares, e.g.:
NATAL-2829 (Harrismith): Cathedral Peak Forest Station (-CC), *Killick B127* (PRE); . . .
CAPE-3418 (Simonstown): Hottentots Holland mountains, Somerset Sneeukop (-BB), Nov., *Stokoe s.n.* sub. SAM *56390* (SAM)

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These should be given in the text as follows: Jones (1968) or (Jones, 1968) or, where reference to a specific page is required, Jones (1968: 57) or (Jones, 1968: 57). **Literature cited** should be arranged alphabetically by surnames, chronologically within each name, with suffixes a, b, etc., to the year for more than one paper by the same author in that year. Titles of **periodicals** must be abbreviated according to the *World List of Scientific Periodicals*, 4th ed., London: Butterworth or when unable to trace the title in this list (as will be the case in taxonomic papers where abbrevations of 18th and 19th century periodicals are required) the abbreviations given in *Botanico-Periodicum-Huntianum,* Pittsburgh: Hunt Botanical Library, 1968, should be followed. Periodical titles should be underlined once (for italics). If an author is unable to determine the correct abbreviation of a journal title he is advised to type it out in full and leave its abbreviation to the Editor. Titles of **books** should be underlined and given in full, together with the place of publication, name of the publisher and an indication of the edition if other than the first; e.g.:

Davis, P. H. and Heywood, V. H., 1963. *Principles of Angiosperm Taxonomy*. Edinburgh and London: Oliver and Boyd.

Riley, H. P., 1960. Chromosome numbers in the genus *Haworthia. Jl S. Afr. Bot.* **26:** 139–148.

Jl S. Afr. Bot. 43 (4): 233–241 (1977)

HABITAT OF RESTIONACEAE ENDEMIC TO WESTERN CAPE COASTAL FLATS

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ABSTRACT

Chondropetalum acockii and *Restio micans* (family Restionaceae) are endemic to the western coastal flats of the south-western Cape. Both species are associated with Coastal Fynbos on sand. The habitats of *C. acockii* and *R. micans* are described and compared using associated plants (Restionaceae and Proteaceae) as an expression of environmental conditions.

UITTREKSEL

HABITAT VAN RESTIONACEAE ENDEMIES OP DIE WESTELIKE KAAPSE KUSVLAKTES

Chondropetalum acockii en *Restio micans* (familie Restionaceae) het 'n beperkte verspreiding op die westelike kusvlakte van Suidwes-Kaapland. Die twee spesies kom op kusfynbos van die sandveld voor. Die habitat van beide *C. acockii* en *R. micans* word beskryf en met mekaar vergelyk op grond van geassosieerde plantsoorte (Restionaceae en Proteaceae) as weerspieëling van omgewingstoestande.

INTRODUCTION

The Restionaceae are a family physiognomically and floristically characteristic of the south-western Cape's distinctive fynbos vegetation, yet their phytogeography and ecology are relatively poorly documented (Weimarck, 1941; Taylor, 1969, in press; Boucher, 1972). Phytocenological work on Cape fynbos in a coastal area has shown that "the correlation between soil, topography and vegetation is extremely good" (Taylor, 1969). Members of the Restionaceae are regarded as particularly valuable for the recognition of fynbos communities (Taylor, 1969, 1972, in press; Boucher, 1972), partly owing to their apparently greater habitat-specificity than other elements of the flora (Taylor, 1969).

Among the 281 described southern African Restionaceous species (Pillans, 1928, 1942, 1945, 1952) only *Chondropetalum acockii* Pillans, *Restio micans*

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(Kunth) Nees and *R. acockii* Pillans are endemic to the western coastal flats of the south-western Cape. These flats were arbitrarily defined here as from False Bay northwards, west of the Hottentots-Holland-Winterhoek mountain chain to S 32 ° 30′ (the latitude of Piketberg) and eastwards along the intermontane flats to Worcester between sea level and 600 m. The flats have been extensively changed by man, with a consequent decrease in the populations of indigenous plant species. *Chondropetalum acockii* and *R. micans* appear to be in danger of extinction, owing chiefly to land development and the spread of invasive alien *Acacia* species, while *R. acockii*, known only from the type locality near Bellville, appears already to be extinct. Four other species in the Restionaceae have ranges almost restricted to the western flats as defined above. *Leptocarpus impolitus* (Kunth) Pillans and *Thamnochortus punctatus* Pillans occur on sandy substrates northwards to Graafwater and Niewoudtville; *Elegia prominens* Pillans occupies similar environments from Darling southwards to the coastal shelf near Cape Point and Cape Hangklip. *Restio duthieae* Pillans, occurring on clay-rich substrates, extends eastwards along the intermontane flats of the Breede River to Worcester (Rare and Endangered Species Research Group, unpublished). These species are less critically threatened than are *C. acockii* and *R. micans* owing to their wider occurrence.

This paper is the first of a series dealing with the habitat of coastal flats endemics, their intensive study being an urgent prerequisite for their conservation. The aim of this study was to characterize the habitats of *C. acockii* and *R. micans*. We attempted to arrive at a reliable reflection of environmental conditions by a qualitative floristic method, recording the confamilial members of the vegetation associated with these two species. Members of the Proteaceae, also characteristic of fynbos (Taylor, in press), were recorded as an additional sample of the total set of taxa represented in the vegetation, for the purposes of habitat expression.

METHODS

All distribution records for the two study species, *Chondropetalum acockii* and *Restio micans*, were obtained from the literature, Cape herbarium material and unpublished records of the Rare and Endangered Species Research Group. All recorded localities were visited and three populations of each study species were relocated, ''populations'' of a species being arbitrarily defined as stands farther than 2 km apart. These extant populations appeared to represent all parts of the known distribution for each species.

The physiognomy of associated vegetation, site topography and a qualitative description of soil were recorded on site for each population. Average annual precipitation and altitude were also recorded, using the best maps available.

Indirect (floristic) information was mainly used in documenting the habitats of the two study species, both of which are leafless grass-like perennials. *Chondropetalum acockii* grows as 0,7–0,8 m tussocks of unbranched stems, arising from a base consisting of creeping rhizomes; *R. micans* grows as 0,3–0,5 m slender tufts of sparingly branched stems arising from a simple base. All members of the Restionaceae and Proteaceae growing within 0,25 m of plants of each study species were recorded, thereby collecting data only from within the edaphic environment of the study species. This search for associates was continued until all, or a minimum of 12, study plants in each of the three populations of each study species had been investigated. Lists, according to presence or absence, of associate species for each population were combined to show the "between-population frequency" of each associate for each study species. Examples of associates in other families were recorded where possible.

RESULTS AND DISCUSSION

1. *Habitat of* Chondropetalum acockii *Pillans**

Chondropetalum acockii had a restricted range on the western coastal flats of the south-western Cape, from Bellville to Mamre Road (Fig. 1). The species was confined to deep, pale, transported sand of Tertiary origin on level and gently sloping sites. Populations were at altitudes of 90–120 m and received annual precipitation of 450–550 mm.

The vegetation associated with *C. acockii* was a mainly restioid-ericoid (*sensu* Taylor, in press) Coastal Fynbos, 1,0–1,5 m high. The floristic composition of the vegetation associated with the three populations appeared similar. Examples of species in common were *Diosma oppositifolia, Muraltia brevicornu, Phylica stipularis, Staavia radiata, Berzelia abrotanoides* and several members of the Restionaceae and Proteaceae (Table 1).

Chondropetalum acockii occurred near Mamre Road as a conspicuous member of an open stand (canopy cover 70–80 %) comprising a main 0,8 m stratum of ericoid shrubs (e.g. *Phylica cephalantha, Elytropappus gnaphaloides, Metalasia* spp.) and tufted restioids (e.g. *Thamnochortus punctatus*). Proteoid shrubs of *Leucospermum parile* formed a more open upper stratum to 1,2 m, while scattered spindly shrubs of *Muraltia brevicornu* emerged to 1,5 m. Populations of *C. acockii* near Philadelphia and Bellville occurred in stands similar in structure; *Leucospermum parile* was, however, absent, the proteoid stratum being reduced to widely scattered shrubs of *Leucadendron salignum* or *Protea repens*. The set of plant species collectively associated with *C. acockii* (Table 1, Appendix 1a) bore little resemblance to those representing described communities of other sandy coastal flats (Taylor, 1969, 1972; Boucher, 1972; Boucher & Jarman, 1977), none of which cover the area of distribution of *C. acockii*.

2. *Habitat of* Restio micans *(Kunth) Nees*

Restio micans had a restricted range on the western coastal flats of the south-western Cape, occurring on the Cape Flats, near Bottelary and near Mamre

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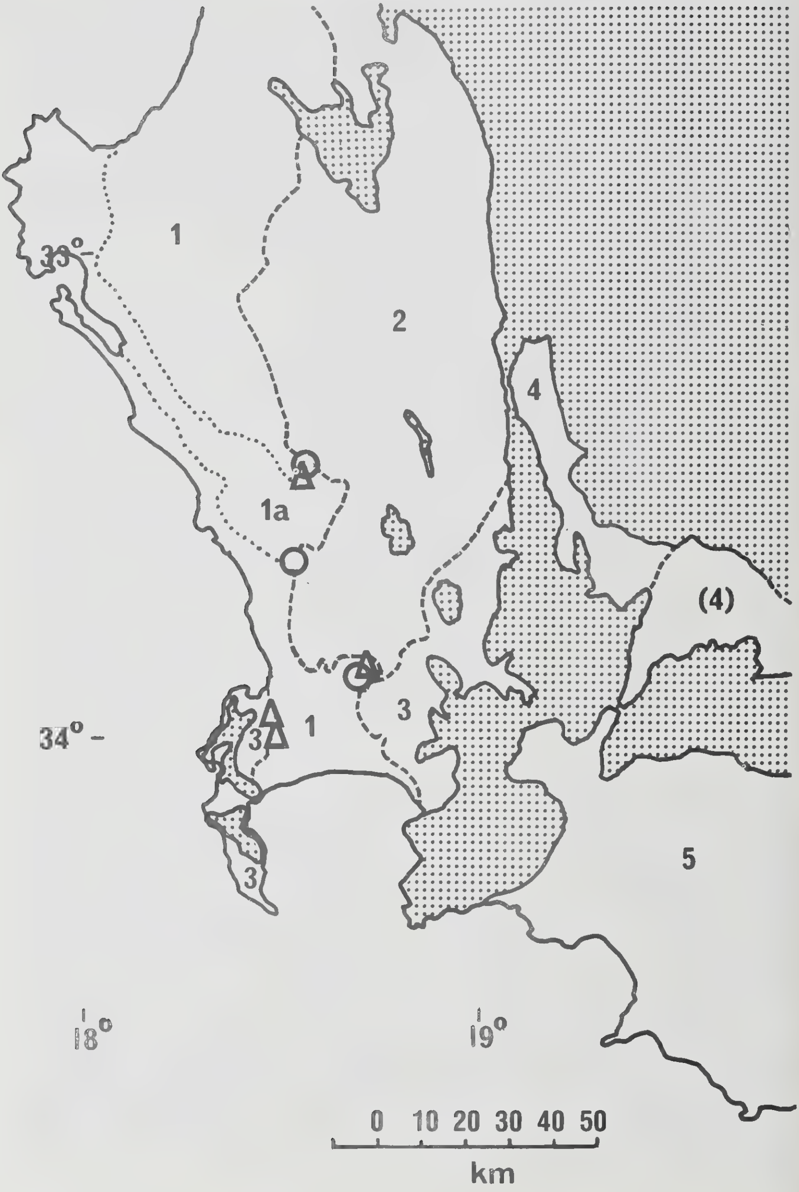
*collections of voucher specimens of the study species and their associates are housed at the Bolus Herbarium, University of Cape Town.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Road (Fig. 1). The species was confined to pale, transported sand of Tertiary origin on level sites. Populations were at altitudes of 20–125 m and received annual precipitation of 450–850 mm. *Restio micans* occurred in small shallow depressions and at the base of gentle slopes, where the substrate was seasonally waterlogged owing to drainage poorer than on adjacent sandy ground.

The vegetation associated with *R. micans* was a mainly restioid Coastal Fynbos, 0,5–1,8 m high. The floristic composition of the associated vegetation appeared heterogeneous; few species were noted as common to two or more of the three populations, other than several members of the Restionaceae and Proteaceae (Table 1).

Restio micans occurred near Kenilworth as a conspicuous member of a stand resembling Taylor's (1969) Restionaceous Tussock Marsh Association. Species in common included *Elegia parviflora, Restio quinquefarius, R. bifurcus, Chondropetalum nudum, Erica corifolia, Scyphogyne muscosa, Cliffortia subsetacea, Serruria glomerata* and *Berzelia abrotanoides.* Taylor's Restionaceous Tussock Marsh Association occurs on the southern Cape Peninsula in shallow depressions and on drainage line flats, on transported sand and on soils ("Cartref" and "Witsand") derived from Table Mountain Sandstone (Taylor, 1969). It is associated with poor drainage, "where water is stagnant during winter but dries up during summer" (Taylor, 1969). Sets of plant species associated with other populations of *R. micans* (Table 1, Appendix 1b) bore little resemblance to those representing described communities. Associates of *R. micans* considered characteristic of moist edaphic conditions include *Fuirena hirsuta, Gladiolus angustus, Drosera trinervia, Berzelia abrotanoides, Psoralea pinnata, Helichrysum serpylli-*

FIG. 1*

The south-western Cape, modified after Talbot (1971) and Acocks (1975), showing distribution of *Chondropetalum acockii* (○) and *Restio micans* (Δ) in relation to biotic areas. Stippled areas are mountains largely of Table Mountain Sandstone covered mainly by Mountain Fynbos (Acocks' *Macchia*). 1 = "sandveld" (including the Cape Flats and Fish Hoek valley), flats of Tertiary to Recent sand covered mainly by Coastal Fynbos (Acocks' *Coastal Macchia*) (1a = that part covered mainly by Acocks' *Coastal Rhenosterbosveld*, delineated by dotted line); 2 = "swartland", flats of Malmesbury shale covered mainly by Coastal Rhenosterbosveld; 3 = "voorberg" and coastal flats of the Cape Peninsula (a foothill zone intermediate between the mountains and areas 1 & 2); 4 = "Breërivier Valley", intermontane flats of Malmesbury shale, Recent sand and alluvial deposits, covered by vegetation of mixed affinities; (4) = area 4 east of Worcester; 5 = "ruêns", southern coastal flats, largely of Bokkeveld shale and covered mainly by Coastal Rhenosterbosveld and Coastal Macchia. The "western Cape coastal flats" here comprise areas 1, 2, 3 and 4 (excluding (4)). Data were collected at all localities shown for the two study species. Localities mapped here extend the recorded distributions of *C. acockii* and *R. micans* to the north; both species were previously known only from the Cape Flats (Weimarck, 1941), where most populations at the localities shown have disappeared under urban development.

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*TALBOT, W. J., 1971. *The South African Landscape.* 1. South African Geographical Society.

TABLE 1

Restionaceous and Proteaceous associates of *Restio micans* (column 1) and *Chondropetalum acockii* (column 2). Occurrence values show between-population frequency of associates: numerator is number of populations in which the associate was found within 0,25 m of plants of study species, denominator is total number of populations of study species ("+" indicates associates found in the vicinity of the study species, but not within 0,25 m). Mean number of study plants investigated per population was 56 for *R. micans* (range 12–75) and 54 for *C. acockii* (range 22–65).

Associate species	Occurrence with study species 1	Occurrence with study species 2
Restio macer Kunth	+	
Elegia neesii (Mast.) Mast.	+	
Elegia prominens Pillans	+	
Serruria glomerata R.Br.	1/3	
Leucadendron levisanus (L.) Berg	1/3	
Restio tetragonus Thunb.	1/3	
Restio quinquefarius Nees	2/3	+
Leucadendron cinereum (Solander ex Ait.) R.Br.	2/3	+
Elegia parviflora Kunth.	2/3	+
Restio triticeus Rottb.	1/3	+
Restio paludosus Pillans	3/3	1/3
Staberoha cernua (L.f.) Dur. & Schinz	2/3	1/3
Thamnochortus obtusus Pillans	1/3	1/3
Hypodiscus aristatus (Thunb.) Nees	1/3	1/3
Serruria ciliata R.Br.	1/3	1/3
Chondropetalum tectorum (L.) Pillans	1/3	1/3
Leucadendron salignum Berg.	1/3	1/3
Thamnochortus gracilis (Dur. & Schinz) Mast.	1/3	1/3
Chondropetalum nudum (Nees) Rottb.	2/3	2/3
Serruria burmannii R.Br.	+	+
Willdenowia sulcata Mast.	2/3	3/3
Restio bifurcus Nees ex Mast.	2/3	3/3
Leucospermum hypophyllocarpodendron (L.) Druce ssp. *canaliculatum* (Buek ex Meisn.) Rourke	2/3	3/3
Restio cuspidatus Thunb.	1/3	2/3
Diastella proteoides (L.) Druce	1/3	2/3
Serruria decipiens R.Br.	1/3	2/3
Thamnochortus punctatus Pillans	1/3	3/3
Leptocarpus impolitus (Kunth) Pillans	1/3	3/3
Staberoha distachya (Rottb.) Kunth	1/3	3/3
Protea pulchra Rycroft	+	1/3
Willdenowia humilis Mast.	+	1/3
Hypodiscus willdenowia (Nees) Mast.	+	1/3
Elegia vaginulata Mast.		1/3
Restio filiformis Poir.		1/3
Restio form of *sieberi* Kunth		1/3
Restio monanthus Mast.		1/3
Protea acaulos Thunb.		1/3
Protea repens (L.) L.		1/3
Serruria linearis Salisb. ex Knight		1/3
Leucospermum parile (Salisb. ex Knight) Sweet		1/3
Cannomois acuminata (Thunb.) Pillans		1/3
Leptocarpus vimineus (Rottb.) Pillans		2/3
Willdenowia arescens Kunth		2/3
Serruria furcellata R.Br.		+
Protea scolymocephala Reich.		+

folium, *Senecio halimifolius* and *Leucadendron levisanus* (Taylor, 1969; Lewis & Obermeyer, 1972; Williams, 1972; Bolus Herbarium mounted specimen labels).

3. *Habitat similarity*

Chondropetalum acockii and *Restio micans* have broadly overlapping geographical ranges, occurring in the same landscapes in several areas (Fig. 1). They grow within 30 m of each other near Mamre Road but were never found to be mutual associates (Table 1).

Percentage similarity between the set of associates for *Chondropetalum acockii* and that for *Restio micans* is shown in Table 2. The value calculated using information on the differences between populations (between-population frequency of associate species) was similar to that using coarser information only on collective presence or absence of associates.

TABLE 2

Percentage similarity between set of Restionaceous and Proteaceous associates for *Restio micans* and that for *Chondropetalum acockii*, using the Czekanowski coefficient. The formula used was $\frac{2w}{A+B} \times 100$ (Bray & Curtis, 1957), where w=number of associates in common, A=number of associates for *R. micans* and B=number of associates for *C. acockii*. Total numbers of associate species ("+" data, Table 1, ignored) were 24 for *R. micans* and 32 for *C. acockii*.

According to presence or absence	According to between-population frequency
63,2 %	51,8 %

The habitats of the two study species thus appear to be 51,8 % similar, assuming (i) that relative similarity of (natural) stands of vegetation reflects relative similarity of habitats, within a single geographical area (*vide* Webb *et al.*, 1970), and (ii) that qualitative (frequency) floristic data, restricted to two sample families, convey adequate information about the vegetation.

This numerical assessment of habitat similarity agreed with our field impression based on the appearance of the vegetation, local topography and soil conditions, and the spatial relationship between the two study species. *Chondropetalum acockii* occurred on sand apparently better drained than that for *R. micans;* in support of this, *Elegia parviflora*, characteristic of poorly drained sites (Taylor, 1969) was associated with *R. micans* but not with *C. acockii*. Several species probably indicative of perennial soil moisture owing to poor drainage, e.g. *Berzelia abrotanoides* and *Chondropetalum nudum* (Taylor, 1969) were, nevertheless, associated with both study species. This supports our impression that the restricted range and very localized occurrence of *C. acockii* is, as with *R. micans*, indicative of a discrete attachment to an edaphic environment moister than that characterizing the major part of the western sandy flats covered by Coastal Fynbos. The two study species thus appear to be restricted to (adjacent) narrow ranges along a gradient in soil moisture.

CONCLUSIONS

The geographical distributions of *Chondropetalum acockii* and *Restio micans* were originally very restricted. Localities have been destroyed by urban development and agriculture, further reducing the species' ranges and making knowledge of their habitats essential for conservation. Remaining populations, apparently temporarily saved from ploughing by the depth of sand on which they grow, do not occur in any entrenched nature reserve and are threatened by a number of factors, chiefly enchroachment by alien *Acacia* species.

Chondropetalum acockii and *R. micans* occupy mutually discrete habitats within a single biotope, viz. Coastal Fynbos on sand. Both species occur near Mamre Road, as comparatively extensive (1–2 ha) adjacent populations. A single carefully placed reserve of 10–15 ha in this area, embracing variations of drainage, slope and depth of sand, could possibly save both species from extinction. Other remaining populations, notably one of *R. micans* at Kenilworth Race Course, should also be strictly preserved to maintain maximal gene pools for the species.

ACKNOWLEDGEMENTS

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Appendix 1a

Examples of plant taxa (excluding Restionaceae and Proteaceae) associated with *Chondropetalum acockii* (order after Engler & Prantl). All taxa were recorded within 0,25 m of plants of *C. acockii.*

Ehrharta gigantea Thunb., *Plagiochloa uniolae* (L.f.) Adamson & Sprague, *Ficinia secunda* (Vahl) Kunth., *Tetraria* spp. indet., *Thesium aggregatum* A. W. Hill, *Polpoda capensis* Presl., *Cassytha ciliolata* Nees, *Berzelia abrotanoides* Brongn., *Staavia radiata* Dahl., *Cliffortia falcata* L.f., *Aspalathus quinquefolia* L. ssp. *virgata* (Thunb.) Dahlgr., *Pelargonium triste* Ait., *Adenandra villosa* (Berg.) Licht. ex Roem. & Schult. ssp. *biseriata* (Mey. ex Bartl. & Wendl.) Strid, *Agathosma imbricata* Willd., *Diosma oppositifolia* L., *Euchaetis dubia* Sond., *Macrostylis villosa* Sond., *Muraltia brevicornu* DC., *Clutia ericoides* Thunb., *Phylica cephalantha* Sond., *P. stipularis* L., *Stylapterus fruticulosus* (L.f.) A. Juss., *Cryptadenia grandiflora* Meisn., *Lachnaea capitata* Meisn., *Passerina vulgaris* Thoday, *Struthiola ciliata* Lam., *Erica crenata* E. Mey. ex Smith, *E. mammosa* L., *Salaxis* sp. indet., *Stilbe ericoides* L., *Agathelpis dubia* (L.) Hutchinson, *Anthospermum* sp. aff. *A. aethiopicum* L., *Disparago lasiocarpa* Cass., *Elytropappus gnaphaloides* (L.) Levyns, *Eroeda capensis* (L.) Levyns, *Metalasia imbricata* (Berg.) Harv., *M. muricata* (L.) Don and *Stoebe gomphrenoides* Berg.

Appendix 1b

Examples of plant taxa (excluding Restionaceae and Proteaceae) associated with *Restio micans*. All taxa were recorded within 0,25 m of plants of *R. micans*.

Cynodon dactylon (L.) Pers., *Stenotaphrum secundatum* (Walt.) O. Kze., *Fuirena hottentota* (L.) Druce (*F. hirta* Vahl), *Scirpus* sp. indet., *Juncus* sp. indet., *Aristea africana* (L.) Hoffmg., *Gladiolus angustus* L., *Lampranthus reptans* (Ait.) N. E. Br., *Ruschia sarmentosa* (Han.) Schwant., *Drosera trinervia* Spreng., *Berzelia abrotanoides* Brongn., *Staavia radiata* Dahl, *Cliffortia polygonifolia* L., *Aspalathus* spp. indet., *Psoralea pinnata* L., *Passerina vulgaris* Thoday, *Erica articularis* L., *E. corifolia* L., *E. ferrea* Berg., *E. imbricata* L., *E. margaritacea* Soland. ex Ait., *E. pulchella* Houtt., *Scyphogyne muscosa* (Ait.) Druce, *Stilbe ericoides* L., *Lightfootia* sp. indet., *Lobelia capillifolia (Presl)* A. DC., *Helichrysum serpyllifolium* (Berg.) Pers. (*H. orbiculare* (Thunb.) Druce), *Metalasia imbricata* (Berg.) Harv. and *Stoebe gomphrenoides* Berg.

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HABITAT OF RESTIONACEAE ENDEMIC TO THE SOUTH-WESTERN CAPE COASTAL FLATS

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ABSTRACT

The habitats of seven species of Restionaceae (genera *Elegia, Restio* and *Thamnochortus)* endemic to the coastal flats of the south-western Cape are described and compared. The species, all associated with Coastal Fynbos, have different habitats, distinguished mainly by soil type (e.g. sand, sandstone, limestone) and drainage. Habitat differences between congeners are numerically assessed using associated plants (Restionaceae and Proteaceae) as an expression of environment.

UITTREKSEL

HABITAT VAN RESTIONACEAE ENDEMIES OP DIE SUID-WESTELIKE KAAPSE KUSVLAKTES

Die habitat van sewe endemiese spesies van Restionaceae (genera *Elegia, Restio* en *Thamnochortus)* wat beperkte verspreidings op die kusvlakte van Suidwes-Kaapland het, word beskryf en met mekaar vergelyk. Die spesies groei almal in kusfynbos maar hulle het verskillende habitatte, hoofsaaklik op grond van bodemtipe onderskei (bv. sand, sandsteen, kalksteen) en dreineringstoestande. Habitatverskille tussen spesies in dieselfde genus word numeries bereken deur geassosieerde plantsoorte (Restionaceae en Proteaceae) as weerspieëling van omgewingstoestande te gebruik.

INTRODUCTION

Twenty-three species of Restionaceae with restricted natural ranges in the south-western Cape are regarded as threatened with extinction owing to man-made environmental changes (Rare and Endangered Species Research Group, unpublished). Information on the distribution and habitat of these species is an urgent prerequisite for their conservation. Ten species of Restionaceae are endemic to what appears to be the most critically altered environment in the south-western Cape, the coastal flats.

The habitats of species of Restionaceae endemic to the western coastal flats were described in a previous paper (Milewski & Esterhuysen, 1977). This study was similar to the previous study but compared in a more general way the habitats of species of wider occurrence, those endemic to an area embracing both western

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and southern coastal flats. This area was arbitrarily defined here as (i) western flats as defined by Milewski and Esterhuysen (1977), but excluding the intermontane Breërivier valley, and (ii) southern flats from Cape Hangklip eastwards, south of the Riviersonderend mountain chain and the Breede River, to Cape Infanta, between sea level and 600 m altitude.

The aim of this study was to describe and interrelate the habitats of seven species of Restionaceae endemic to the coastal flats of the south-western Cape, basing comparisons mainly on a qualitative floristic method used by Milewski and Esterhuysen (1977). The study species were:

(i) *Elegia fenestrata* Pillans,
(ii) *Elegia prominens* Pillans,
(iii) *Elegia verreauxii* Mast.,
(iv) *Restio sabulosus* Pillans,
(v) *Restio dodii* Pillans,
(vi) *Thamnochortus fraternus* Pillans, and
(vii) *Thamnochortus pellucidus* Pillans.

Several other species of Restionaceae have distributions centred on, but not restricted to, the coastal flats as defined here. *Thamnochortus spicigerus* (Thunb.) R.Br., *Chondropetalum microcarpum* (Kunth) Pillans and *Restio eleocharis* Nees ex Mast. have relatively wide ranges along the south-western Cape coast, occurring on littoral and ''inland'' dunes (Weimarck, 1941; Taylor, 1969, 1972; Boucher & Jarman, 1977). *Chondropetalum rectum* (Mast.) Pillans and *Hypodiscus paludosus* Pillans occur throughout the coastal flats on clay-rich substrates, extending into intermontane flats near Wolseley and Villiersdorp. *Thamnochortus pluristachyus* Mast., poorly documented, occurs in the Bredasdorp-Riversdale area. *Staberoha multispicula* Pillans appears restricted to an area between Hermanus and Cape Agulhas but was omitted from this study owing to identification problems and the possibility that it may be conspecific with *S. cernua* (L.f.) Dur. & Schinz.

The seven study species are all leafless perennials. *Elegia fenestrata, Thamnochortus fraternus* and *T. pellucidus* grow as tussocks, respectively 1,5–1,8 m, 0,4–0,6 m and 0,3–0,5 m high, of unbranched stems; *T. fraternus* and *T. pellucidus* arise from a simple base and *E. fenestrata* arises from a rhizomatous base. *Elegia verreauxii* and *Restio sabulosus* form spreading mat-like stands of sparingly branched upright 0,3–0,4 m stems arising from a subterranean base of interwoven rhizomes. *Restio dodii* grows as 0,6–0,8 m tufts of branched stems arising from a simple base. *Elegia prominens* is intermediate in growth form between *E. verreauxii* and *R. dodii*, forming mat-like stands of sprawling branched stems 0,2–0,3 m high, or (in the northern parts of the species' range) more robust tufts 0,4–0,6 m high.

METHODS

All distribution records for the seven study species were obtained from the literature, Cape herbarium material and unpublished records of the Rare and Endangered Species Research Group. Two to five arbitrarily selected sample populations, scattered through the known distribution of each species, were visited, "populations" of a species being defined (Milewski & Esterhuysen, 1977) as stands farther than 2 km apart. Three populations of each species other than *Restio sabulosus* (two populations) and *Elegia prominens* (five populations) were investigated.

The physiognomy of associated vegetation, site topography and altitude, and a qualitative description of soil were recorded on site for populations of each study species. Average annual precipitation, geology and existing vegetation classifications were also recorded, using the best maps available.

Indirect (floristic) information was mainly used in comparing the habitats of the study species, which are grass-like perennials growing as a scattered sward of small tussocks or as dense mat-like colonies of interconnected plants. All members of the Restionaceae and Proteaceae growing within 0,25 m of plants of each study species were recorded, data thereby being collected only within the edaphic environment of the study species. This search for associates was continued until all study plants, or a minimum of 22 study plants scattered throughout the population, had been investigated in each population. Data on associates were thus collected from the vicinity of a total of 120–225 plants of each study species (fewest for *Restio sabulosus*, most for *Elegia prominens*). Lists, according to presence or absence, of Restionaceous associate species for each population were combined to show the "between-population frequency" (Milewski & Esterhuysen, 1977) of each associate for each study species. Lists of Proteaceous associates were combined to show the collective presence or absence of associates for each study species. Examples of associates in other families were recorded where possible.

RESULTS AND DISCUSSION

1. *General*

Figures 1 and 2 show that the study species had very restricted ranges on the coastal flats, *Elegia prominens*, *E. verreauxii* and *Thamnochortus fraternus* being the most widespread. All seven species were shown here to occur more widely than previously believed (Weimarck, 1941). The distributions of all the study species were discontinuous. This probably reflects the still incomplete distributional record, as well as real disjunctions owing to the patchy occurrence of various types of environment.

Table 1 gives miscellaneous information relevant to the habitats of the study species. Tables 2 and 3 show sets of associates, respectively for Restionaceae and

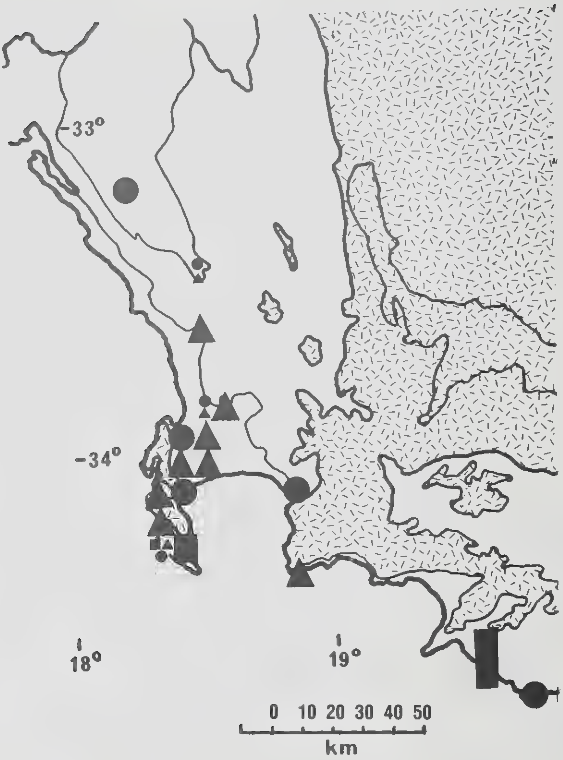

FIG. 1.*

The south-western Cape, modified after Acocks (1975) and Milewski and Esterhuysen (1977), showing distribution of *Elegia fenestrata* (■), *E. prominens* (▲), and *E. verreauxii* (●) in relation to biotic areas. Localities were plotted using a twelfth-degree grid, each symbol representing the presence of the species within a square covering one-ninth of the area of a quarter-degree grid-square (smaller versions of the symbols were used where two or more species were recorded in the same grid-square). Stippled areas are mountains largely of Table Mountain Sandstone covered mainly by Mountain Fynbos (Acocks' *Macchia*); enclosed area within this is a major intermontane valley. Clear areas are part of the coastal flats as defined, collectively comprising ''sandveld'', ''swartland'' and ''voorberg'' (western flats), and ''ruêns'' (southern flats) areas distinguished by Milewski and Esterhuysen (1977). The ''Coastal Fynbos biotope'' is found mainly in the delineated western part (''sandveld'') of the western flats, and in the southern part of the southern flats.

**Elegia fenestrata* appears also to be recorded from S 34° 01′ E 24° 36′ (*Fourcade 2184*, from ''bed of Rooipunt River,'' cited as *Elegia thyrsifera* Pers. by Pillans in 1928.)

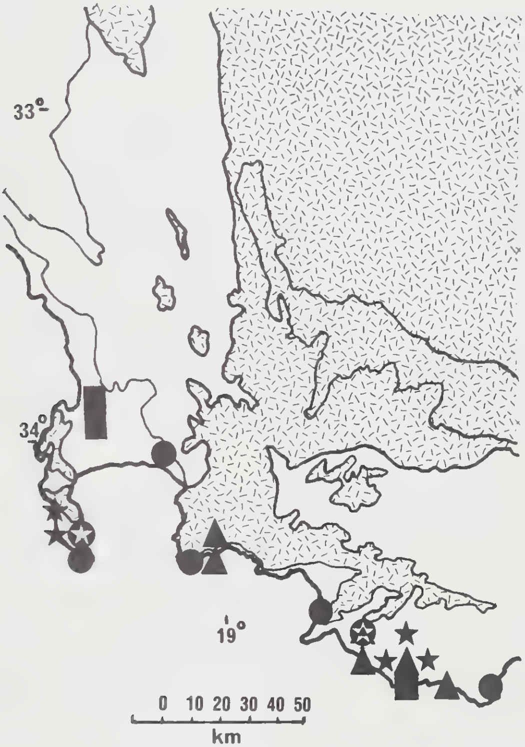

FIG. 2.
The south-western Cape as in Figure 1, showing distribution of *Restio sabulosus* (■), *R. dodii* (★), *Thamnochortus fraternus* (●) and *T. pellucidus* (▲). The symbols and indicate respectively that *R. dodii* and *T. fraternus*, and *R. dodii*, *T. fraternus* and *T. pellucidus*, were recorded in the same grid-square.

Proteaceae. The column sequence in the tables interrelates the study species on the basis of associates shared, owing to the arrangement of rows and columns.

2. *Elegia fenestrata* Pillans

Elegia fenestrata (Fig. 1) was confined to perennially moist or waterlogged sites along gently sloping drainage lines, on transported sand of Tertiary* and probably also Table Mountain Sandstone origin. It occurred near Cape Point on the littoral foreland within 200 m of the sea and on sand extending inland along a depression on a Table Mountain Sandstone plateau; populations near Quoin Point lined the phreatic zones of a number of coastal shelf streams at the base of steep limestone hills.

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*to Recent

The vegetation associated with, and usually dominated by, *E. fenestrata* was a mainly graminoid (*sensu* Taylor, in press) Coastal Fynbos, 1–3 m high. Species recorded with two or more populations included *Schoenus nigricans, Juncus kraussii, Rhus laevigata, Leucadendron coniferum, Metalasia muricata, Helichrysum serpyllifolium* and several members of the Restionaceae (Table 2). The set of plant species collectively associated with *E. fenestrata* had much in common (Appendix 1) with lists representing communities on soil of pH 7,0–7,5 and seasonally waterlogged depressions on marine-derived sand (including shallow sand overlying limestone) on the Cape Peninsula and False Bay coast. Associates also included several species listed from communities on better-drained sandy flats, lower (''Fernwood'') dune slopes and surface limestone (pH 6,7–7,5), and others from seepage fynbos communities (Appendix 1).

3. *Elegia prominens* Pillans

Elegia prominens occurred on the coast and coastal flats between Darling and Cape Hangklip (Fig. 1). The species was confined to level and gently sloping sites on transported sand of Tertiary to Recent origin, usually on low-lying, comparatively poorly drained ground.

The vegetation associated with *E. prominens* was a restioid-ericoid-proteoid (*sensu* Taylor, in press) Coastal Fynbos, 0,3–1,8 m high. Communities with different populations showed wide floristic variation; species recorded with three or more populations included several members of the Restionaceae (Table 2). *Elegia prominens* occurred on the coastal shelf of the southern Cape Peninsula in vegetation resembling described communities (Table 1, Appendix 1) of marshy flats as well as of better-drained loose sands (probably alkaline) on which *Thamnochortus erectus* was dominant. An erect-tufted, ''giant'' form of *E. prominens* occurred near Mamre Road and near Philadelphia in 1,6–1,8 m high vegetation similar to that in which a northern population of *Restio micans* grew (Milewski & Esterhuysen, 1977), with, e.g. *Leucadendron cinereum, Elegia parviflora, Chondropetalum nudum, C. tectorum, Berzelia abrotanoides, Erica* spp. and *Metalasia* spp.

4. *Elegia verreauxii* Mast.

Elegia verreauxii (Fig. 1) occurred between Hopefield and Cape Agulhas. The species was confined to level sites on sandy substrates, ranging from Table Mountain Sandstone-derived sand to fine-grained, pale Tertiary sand with an admixture of clay, and Tertiary ''calcified dune sand'' of the Bredasdorp beds. It occurred on the floors of broad, poorly-drained depressions, where the soil was perennially moist and seasonally waterlogged.

The vegetation associated with, and usually dominated by, *E. verreauxii* was a mainly restioid fynbos, 0,2–0,5 m high. Communities with different populations showed wide floristic variation; species recorded with two or more populations included *Gnidia viridis, Cynodon dactylon, Elegia prominens, Restio sabulosus* and several other members of the Restionaceae (Table 2). *Elegia verreauxii* occurred on the northern Cape Flats in vegetation sharing several species with communities (Appendix 1) of similar moist depressions overlying limestone and sandstone on the False Bay coast. *Arthrocnemum* sp. or spp. and *Plantago carnosa*, among these, appear indicative that *E. verreauxii* is comparatively tolerant of edaphic salinity.

5. *Restio sabulosus* Pillans

Restio sabulosus (Fig. 2) was confined to level sites on fine-grained transported sand of Tertiary to Recent origin, including "calcified dune sand" of the Bredasdorp beds. The species occurred on the floors of broad coastal depressions inland from the littoral dunes, under conditions of drainage similar to those for *Elegia verreauxii*.

The vegetation associated with *R. sabulosus* was a mainly restioid Coastal Fynbos, 0,2–0,5 m high. Communities on the Cape Flats and near Quoin Point appeared to differ floristically; species recorded with both populations included *Gnidia viridis, E. verreauxii* and several other members of the Restionaceae (Table 2). *Restio sabulosus* occurred on the northern Cape Flats in vegetation sharing several species with communities (Appendix 1) of similar moist depressions on the False Bay coast. The species was associated in both known populations with *E. verreauxii;* the habitat range of *R. sabulosus* appeared to fall within that of *E. verreauxii*, which evidently extended elsewhere on to soils with higher clay or salt content. An associate with the western population of *R. sabulosus* was the rare Cape Flats endemic *Cliffortia ericaefolia*.

6. *Restio dodii* Pillans

Restio dodii had a disjunct range (Fig. 2) on the south-western Cape coastal flats, near Cape Point (var. *dodii*) and in the Bredasdorp area (var. *purpureus* Pillans). The species was apparently confined to poorly drained sandy soil, described by Taylor (1969), derived from Table Mountain Sandstone.

The vegetation associated with *R. dodii* was a mainly restioid-ericoid, 0,6–1,2 m high fynbos intermediate in appearance between Coastal Fynbos and Mountain Fynbos (*sensu* Taylor, in press). Species recorded with two or more populations included *Cliffortia subsetacea, Helichrysum serpyllifolium, Berzelia abrotanoides, B. lanuginosa, Scyphogyne muscosa* and several members of the Restionaceae (Table 2). *Restio dodii* occurred on the coastal plateau near Cape Point in floristically well-documented marsh communities (Table 1, Appendix 1). The species grew near Pearly Beach in similar vegetation.

TABLE 1

Precipitation, altitudinal range, substrates and most-detailed mapped plant communities for sites of populations of seven study species of Restionaceae.

Study species	Average annual precipitation (mm)	Altitudinal range (m)	Substrate	Most-detailed mapped plant community	
				Name	Author
Elegia fenestrata	600–650	40–115	shallow to deep sand over Table Mountain Sandstone (possibly also over Alexandria limestone)	Dune Mixed Fynbos Association (Coast Fynbos Alliance); between Restionaceous Tussock Marsh and *Eriocephalus* Coast-shelf Fynbos (Coast Fynbos Alliance)	Taylor (1969)
Elegia prominens	550–950	6–90	deep sand over Table Mountain Sandstone, Cape Granite, and Malmesbury shale (possibly also over Alexandria limestone)	(i) between *Eriocephalus* Coast-shelf Fynbos (Coast Fynbos Alliance), Restionaceous Tussock Marsh (Inland Fynbos Alliance) and *Sideroxylon* Scrub	Taylor (1969)
				(ii) *Eriocephalus* Coast-shelf & Dune Fynbos (Coast Fynbos Alliance)	Taylor (1969)
				(iii) probably Mixed Coastal Fynbos of Acid Sands (Coastal Plain Vegetation)	Boucher (1972)
				(iv) Coastal Dune Vegetation, or *Leucadendron coniferum* Limestone Fynbos (Coastal Plain Vegetation)	Boucher (1972)

				Vegetation, or *Leucadendron coniferum* Limestone Fynbos (Coastal Plain	
Elegia verreauxii	350–900	80–90 (one herbarium specimen from 300)	shallow to deep sand over Table Mountain Sandstone, Cape Granite, Malmesbury shale	(i) Restionaceous Tussock Marsh (Inland Fynbos Alliance)	Taylor (1969)
				(ii) overall distribution of the species centred on Coastal Macchia	Acocks (1975)
Restio sabulosus	500–550	8–30	shallow to deep sand over Malmesbury shale, Table Mountain Sandstone	Coastal Macchia	Acocks (1975)
Restio dodii	see Taylor (1969)	see Taylor (1969)	very shallow to shallow, peaty sand over Table Mountain Sandstone	(i) Restionaceous Tussock Marsh, partly also in *Berzelia-Osmitopsis* Seepage Scrub (Inland Fynbos Alliance)	Taylor (1969)
				(ii) Coastal Macchia	Acocks (1975)
Thamnochortus fraternus	550–900	5–150	very shallow to shallow sand over limestone	(i) Dwarf Dune Mixed Fynbos Sub-association (Coast Fynbos Alliance)	Taylor (1969)
				(ii) *Leucadendron coniferum* Limestone Fynbos (Coastal Plain Vegetation)	Boucher (1972)
Thamnochortus pellucidus	500–900	30–100	shallow sand over Table Mountain Sandstone (possibly also over Alexandria limestone)	(i) boundary between Mixed Coastal Fynbos of Acid Sands (Coastal Plain Vegetation) and Mixed Ericoid and Restioid Fynbos of the Xeric Seaward Slopes (Coastal Mountain Fynbos)	Boucher (1972)
				(ii) overall distribution of species centred on Coastal Macchia	Acocks (1975)

TABLE 2.

Restionaceous associates, according to "between-population frequency", of seven Restionaceous study species: 1 = *Thamnochortus fraternus*, 2 = *Elegia fenestrata*, 3 = *Thamnochortus pellucidus*, 4 = *Restio sabulosus*, 5 = *Elegia verreauxii*, 6 = *Elegia prominens*, 7 = *Restio dodii*. Mean number of study plants investigated per population was (range in parentheses): 1 = 48 (35–65), 2 = 62 (50–85), 3 = 50 (40–58), 4 = 60 (50–70), 5 = 66 (50–76), 6 = 45 (35–58), 7 = 52 (22–60). Numerator equals the number of populations in which the associate species was recorded within 0,25 m of plants of the study species; denominator equals total number of investigated populations of the study species; "+" denotes that the Restionaceous associate species was present in the same stand of vegetation as the study species, but not recorded within 0,25 m.

Associate species	Occurrence with study species						
	1	2	3	4	5	6	7
Restio leptocladus Mast.	1/3						
Restio eleocharis Nees ex Mast.	2/3						
Leptocarpus paniculatus (Rottb.) Mast.		1/3					
Leptocarpus asper (Mast.) Pillans			1/3				
Leptocarpus sp. nov. aff. *L. fruticosus* Mast.			1/3				
Thamnochortus guthrieae Pillans			1/3				
Leptocarpus hyalinus (Mast.) Pillans			1/3				
Restio egregius Hochst.			1/3				
Elegia stipularis Mast.			3/3				
Hypolaena digitata (Thunb.) Pillans			2/3				
Thamnochortus gracilis (Dur. & Schinz) Mast.			2/3				
Staberoha multispicula Pillans			2/3				
Leptocarpus vimineus (Rottb.) Pillans				1/2	1/3		
Elegia prominens Pillans (including giant form)				+	2/3		
Thamnochortus obtusus Pillans				+	+		
Chondropetalum rectum (Mast.) Pillans					1/3		
Restio sp. nov. aff. *R. tenuissimus* Kunth					1/3	+	
Restio sabulosus Pillans					2/3	+	
Restio macer Kunth					1/3	1/5	
Thamnochortus punctatus Pillans						+	
Leptocarpus impolitus (Kunth) Pillans						+	
Restio micans (Kunth) Nees						+	
Willdenowia arescens Kunth						1/5	
Hypodiscus willdenowia (Nees) Mast.						2/5	

Associate species	Occurrence with study species						
	1	2	3	4	5	6	7
Willdenowia sulcata Mast.						2/5	
Restio cincinnatus Mast.						+	+
Restio paludosus Pillans						1/5	2/3
Restio quinquefarius Nees						1/5	2/3
Restio bifurcus Nees ex Mast.						2/5	2/3
Elegia asperiflora (Nees) Kunth							+
Elegia thyrsifera (Rottb.) Pers.							+
Willdenowia humilis Mast.							+
Hypolaena sp. indet.							1/3
Restio pedicellatus Mast.							1/3
Restio bifidus Thunb.							1/3
Elegia cuspidata Mast.							2/3
Leptocarpus fruticosus Mast.	3/3	2/3	1/3				
Willdenowia teres Thunb.	2/3	1/3	2/3				
Chondropetalum microcarpum (Kunth) Pillans	1/3	1/3		1/2	1/3	2/5	
Thamnochortus fruticosus Berg.	1/3			+	+	1/5	
Thamnochortus erectus Thunb. (Mast.)	1/3					2/5	
Chondropetalum tectorum (L.) Pillans (including small form)		3/3		1/2	1/3	2/5	
Elegia verreauxii Mast.				2/2		2/5	
Restio sp. or spp. aff. *R. tenuissimus* Kunth			3/3	1/2	1/3	1/5	
Restio cuspidatus Thunb.			3/3	+	+	2/5	
Restio triticeus Rottb.		1/3	1/3	2/2	3/3	3/5	
Chondropetalum nudum (Nees) Rottb.		1/3	1/3	2/2	3/3	4/5	2/3
Elegia fistulosa Kunth		1/3					+
Restio compressus Rottb.		1/3					3/3
Elegia parviflora Kunth (including several forms)			3/3	1/2	2/3	3/5	3/3
Elegia neesii (Mast.) Mast.			1/3			1/5	2/3
Staberoha distachya (Rottb.) Kunth*			+			+	+
Staberoha cernua (L.f.) Dur. & Schinz			1/3				2/3
Hypodiscus aristatus (Thunb.) Nees			2/3				+
Elegia vaginulata Mast.				+	+		1/3

*Note that in some cases it was impossible to distinguish between *S. distachya* and *S. cernua*.

7. *Thamnochortus fraternus* Pillans

Thamnochortus fraternus (Fig. 2) was evidently confined to well-drained, lime-rich coastal deposits of Tertiary to Recent transported origin between Cape Point and Cape Agulhas. It occurred on substrates ranging from small pockets of soil (''Mispah'' form, ''Muden'' series) on outcrops of limestone, to sand apparently more than 1 m deep overlying limestone or sandstone. The species was found, for example, near Cape Point on the level surface limestone, and derived fine-grained soil, of a calcified dune overlying a Table Mountain Sandstone plateau, at Hangklip on calcified aeolian sand piled steeply against seaward Table Mountain Sandstone slopes, and at Pearly Beach on the steep hill slopes of exposed limestone of the Alexandria beds.

The 0,4–2,0 m high vegetation associated with *T. fraternus* ranged from proteoid-ericoid-restioid Coastal Fynbos to communities transitional between fynbos and broad-leaved littoral dune scrub (''strandveld'' *sensu* Taylor, in press). Species recorded with two or more populations included *Asparagus stipulaceus, Myrica quercifolia, Senecio arnicaeflorus, Passerina paleacea, Rhus glauca, Euclea racemosa, Lightfootia tenella, Carpobrotus acinaciformis, Erica coccinea, Knowltonia capensis, Pelargonium betulinum, Limonium scabrum* and several members of the Restionaceae (Table 2).

The set of plant species collectively associated with *T. fraternus* had much in common (Appendix 1) with lists representing fynbos on calcified dunes on the False Bay coast, vegetation partly ''of transitional nature with elements of dune scrub'' (Boucher, 1972). *Thamnochortus fraternus* has, for example, previously been found to be confined to a fynbos community restricted in the Cape of Good Hope Nature Reserve to calcified dunes, and containing ''many plants absent or rare elsewhere in the Reserve'' (Taylor, 1969). A population of *T. fraternus* near Hangklip, by contrast, shared more associates with broad-leaved littoral dune scrub than it did with fynbos on calcified dunes. *Carpobrotus acinaciformis, Restio eleocharis, Psoralea fruticans, Passerina paleacea, Myrica cordifolia* and *Metalasia muricata* were, for example, among the characteristic species for Boucher's (1972) *Colpoon-Rhus* Dune Scrub, whereas only *Metalasia muricata* and *Senecio arnicaeflorus* were among his characteristic species for *Leucadendron coniferum* Limestone Fynbos.

8. *Thamnochortus pellucidus* Pillans

Thamnochortus pellucidus occurred on the coast between Cape Hangklip and Cape Agulhas (Fig. 2). The species was confined to gently sloping sites on pale transported sandy soil of Table Mountain Sandstone or Tertiary origin, apparently including ''calcified dune sand'' of the Bredasdorp beds. Most known populations were on the coastal shelf between the littoral dunes and cliffs and the first inland hill-slopes. The species was found, for example, near Brandfontein (Bredasdorp coast) at the base of seaward Table Mountain Sandstone slopes and near Klein-

Table 3

Proteaceous associates, according to collective presence and absence, of seven Restionaceous study species: 1 = *Thamnochortus fraternus*, 2 = *Elegia fenestrata*, 3 = *Thamnochortus pellucidus*, 4 = *Restio sabulosus*, 5 = *Elegia verreauxii*, 6 = *Elegia prominens*, 7 = *Restio dodii* (sample sizes as for Table 2). "×" denotes that the Proteaceous associate species was recorded within 0,25 m of a plant of the study species; "+" denotes that the species was present in the same stand of vegetation as the study species, but not recorded within 0,25 m.

Associate species	Occurrence with study species						
	1	2	3	4	5	6	7
Leucadendron meridianum Williams	×						
Protea obtusifolia Buek.	×						
Leucospermum patersonii Phillips	×						
Mimetes saxatilis Phill.	×						
Leucospermum pedunculatum Klatzsch in Krauss		×	×				
Mimetes cucullata (L.) R.Br.		×	×				
Leucospermum hypophyllocarpodendron (L.) Druce ssp. *hypophyllocarpodendron*		+	×			+	
Protea subulifolia (Salisb. ex Knight) Rourke			×				
Protea susannae Phillips			×				
Serruria nervosa Meisn.			×				
Leucospermum pedunculatum × *hypophyllocarpodendron* (hybrid)			×				
Spatalla ericoides Phillips			×				
Aulax umbellata (Thunb.) R. Br.			×				
Serruria adscendens R. Br.			×				
Serruria bolusii Phill. & Hutch.			×				
Leucadendron levisanus (L.) Berg.				×	×	+	
Leucadendron corymbosum Berg.					×		
Leucadendron cinereum (Solander ex Ait.) R. Br.					×	×	
Serruria decipiens R. Br.					+	×	
Leucospermum hypophyllocarpodendron (L.) Druce ssp. *canaliculatum* (Buek ex Meisn.) Rourke						+	
Protea scolymocephala Reich.						+	
Diastella proteoides (L.) Druce						×	
Diastella divaricata (Berg.) Rourke						×	+
Serruria glomerata R. Br.						×	×
Leucadendron laureolum (Lam.) Fourcade							×
Leucadendron floridum R. Br.							×
Protea cynaroides L.							+
Leucadendron coniferum (L.) Meisn.	×	×	+			+	
Leucadendron xanthoconus (O. Ktze.) K. Schum.		×	×				×
Leucadendron salignum Berg.			×			×	
Leucadendron linifolium (Jacq.) R. Br.			×	×	×		
Serruria ciliata R. Br.				×	×	×	

TABLE 4

Percentage similarity between sets of associates for seven study species of Restionaceae, using "between-population frequency" data on Restionaceous associates (Table 2) to calculate the Czekanowski coefficient. The formula used was $\frac{2w}{A+B} \times 100$ (Bray & Curtis, 1957), where w = number of associate species in common, A = number of associates for one study species, and B = number of associates for another study species. Values in parentheses are percentage similarity between sets of Restionaceous and Proteaceous associates for congeneric pairs of study species (collective presence and absence data only on all associates, Tables 2 & 3, for each study species were used). "+" data in Tables 2 and 3 were ignored.

	Study species						
	1	2	3	4	5	6	7
1. *Thamnochortus fraternus*		34,8	13,9 (8,9)	3,3	6,1	3,6	0
2. *Elegia fenestrata*			18,2	12,7	23,5 (25,8)	5,7 (20,5)	11,1
3. *Thamnochortus pellucidus*				7,8	18,5	6,6	21,4
4. *Restio sabulosus*					31,3	14,2	6,9 (13,8)
5. *Elegia verreauxii*						14,3 (50,0)	17,4
6. *Elegia prominens*							8,5
7. *Restio dodii*							

mond on a sandy bank lining a perennial stream farther inland in similar country; peripheral hill-slopes near Quoin Point were, by contrast, of Alexandria limestone.

The vegetation associated with *T. pellucidus* was a mainly restioid-ericoid fynbos, 0,5–0,8 m high. Species recorded with two or more populations included *Erica imbricata*, *E. pulchella*, *Mimetes cucullata*, *Leucospermum pedunculatum*, *L. hypophyllocarpodendron*, *Helichrysum sesamoides*, *Phaenocoma prolifera*, *Staavia radiata*, *Penaea mucronata*, *Aspalathus callosa* and several members of the Restionaceae (Table 2). The set of plant species collectively associated with *T. pellucidus* had much in common with a list representing a previously described community on acidic soil of "Fernwood" form and "sandveld" series (Appendix 1). A population of *T. pellucidus* near Kleinmond was sited marginally (Table 1) to the area mapped by Boucher (1972) for this community.

9. *Comparison of habitats of congeneric study species*

Table 4 shows percentage similarity between sets of Restionaceous associate species for the study species, calculated using information on the differences between populations ("between-population frequency"). Similarity values were generally low; the only pairs of species for which there was more than 30% similarity between sets of associates were *Restio sabulosus* with *Elegia verreauxii*, and *Thamnochortus fraternus* with *Elegia fenestrata*. The only pair of congeneric species showing more than 20% similarity was *E. fenestrata* with *E. verreauxii*; however, *E. prominens* showed 50% similarity with *E. verreauxii* at a coarser level, i.e. according to collective presence and absence of both Restionaceous and Proteaceous associates.

This numerical assessment of similarities can be viewed as a preliminary measure of habitat similarity for the study species. However, such an interpretation assumes that qualitative floristic data, restricted to two sample families, convey an adequate and valid reflection of the range of environmental conditions under which the study species grow.

Elegia fenestrata, *E. prominens* and *E. verreauxii* are partly sympatric (*sensu* Davis & Heywood, 1967) and show some habitat overlap; *E. prominens* and *E. verreauxii* occur together as associates in certain areas. All three species appear restricted to relatively poorly drained sandy soils, *E. fenestrata* evidently occurring on permanently waterlogged, *E. verreauxii* (with *Restio sabulosus*) on seasonally waterlogged, and *E. prominens* on seasonally moist to waterlogged ground. The habitat range of *E. prominens* appears akin to but wider than that of sympatric *Restio micans*, a species of more restricted occurrence (Milewski & Esterhuysen, 1977).

The two study species of *Restio* are partly sympatric and appear both to occupy seasonally waterlogged flats environments. Their habitats are, however, evidently distinct, *R. sabulosus* growing on littoral sand and *R. dodii* on the sandstone coastal plateau.

Thamnochortus fraternus and *T. pellucidus*, both growing on well-drained flats and slopes of the coastal shelf and adjacent hills, are largely sympatric. Their habitats are, however, quite different; *T. fraternus* grows mainly on limestone- and *T. pellucidus* mainly on sandstone-derived substrates.

CONCLUSIONS

Elegia verreauxii, Restio dodii and *Thamnochortus pellucidus*, growing partly on Table Mountain Sandstone-derived soil on coastal uplands, occur in communities marginal to the Mountain Fynbos (*sensu* Taylor, in press) biotope. The habitats of all the study species can nevertheless be considered to fall within that of Coastal Fynbos, a heterogeneous (Acocks, 1975), little-studied and poorly defined biotope.

Weimarck (1941), referring to the pronounced floristic endemism in Mountain Fynbos on peaks of the sandstone Cape mountain ranges, stated that endemism on the coastal flats was virtually restricted to "ecologically unique" areas, mainly limestone environments. He regarded the western flats, and the southern flats between Bredasdorp, Riviersonderend and Breede River mouth, to be very poor in endemics relative to the limestone flats, west of Bredasdorp and near Riversdale. Several other workers (Muir, 1929; Taylor, 1969, 1972; Rourke, 1972; Acocks, 1975) have also alluded to the apparent floristic distinctiveness of Coastal Fynbos on calcified substrates. *Leucadendron meridianum* (one of only two members of its genus growing with their root systems intimately associated with parent limestone) is, for example, regarded as "calciphilous", as are *Mimetes saxatilis, Protea obtusifolia* and *Leucospermum patersonii* (Williams, 1972; Rourke, 1972). *Thamnochortus fraternus* is an associate of these members of the Proteaceae and shows little habitat similarity with the other study species; it thus appears to be another species contributing to the floristic distinctiveness of fynbos on limestone. The "ecological uniqueness" of the environments of the other study species appears mainly owing to particular drainage conditions, supplemented by other edaphic factors.

These findings have a bearing on the conservation of coastal flats endemics. All the study species except *T. pellucidus* and *R. sabulosus* occur in an established conservation area, the Cape of Good Hope Nature Reserve. However, the area of limestone and coastal sand in this reserve is limited, and remaining flats environments are rapidly deteriorating, owing chiefly to encroachment of alien *Acacia* species and intensive development for farming and housing. The establishment of a network of edaphically diverse coastal reserves, although long overdue, would greatly improve the prospects for conservation of the full range of Coastal Fynbos species and ecosystems.

APPENDIX 1

Described plant communities showing floristic similarity to collective sets of associates for each study species of Restionaceae

Study species	Plant community		Examples of species in common
	Name	Author	
Elegia fenestrata	*Helichrysum-Scirpus* Marsh Association (Coast Fynbos Alliance) and	Taylor (1969)	*Schoenus nigricans, Carex clavata, Merxmuellera cincta, Juncus kraussii, Chondropetalum tectorum, C. nudum, Pelargonium grossularioides, Cliffortia ferruginea, Myrica quercifolia, Helichrysum serpyllifolium, Othonna quinquedentata, Senecio halimifolius* and *Samolus valerandi*
	Senecio halimifolius-Scirpus nodosus, and *Myrica quercifolia-Zygophyllum fulvum* communities	Milton (unpub.)	
	Inland Dune Fynbos Sub-association and	Taylor (1969)	*Leucadendron coniferum, Willdenowia teres Chondropetalum microcarpum, Erica coarctata*
	Leucadendron coniferum Limestone Fynbos and	Boucher (1972)	
	Willdenowia teres, Ehrharta villosa, Erica coarctata, and *Cliffortia falcata-Chondropetalum microcarpum* communities	Milton (unpub.)	
	Berzelia-Osmitopsis Seepage Scrub Association and	Taylor (1969)	*Berzelia lanuginosa*
	Brunia-Erica Seepage Fynbos	Boucher (1972)	
Elegia prominens	Restionaceous Tussock Marsh Association; Dune Fynbos Association	Taylor (1969)	*Elegia parviflora, Chondropetalum nudum, Restio quinquefarius, R. bifurcus, Pentaschistis curvifolia, Scyphogyne muscosa, Struthiola ciliata, Cliffortia subsetacea, Serruria glomerata* and *Diastella divaricata; Thamnochortus erectus, Phylica stipularis, Cliffortia falcata, C. filifolia* and *Diosma hirsuta*
Elegia verreauxii and *Restio sabulosus*	*Helichrysum-Scirpus* Marsh Association and	Taylor (1969)	*Helichrysum serpyllifolium, Metalasia muricata, Orpheum frutescens, Aspalathus hispida, Schoenus nigricans, Chondropetalum tectorum* and *C. nudum*
	Myrica quercifolia-Zygophyllum fulvum community	Milton (unpub.)	

Study species	Plant community		Examples of species in common
	Name	Author	
Thamnochortus fraternus	1. Fynbos communities: Dwarf Dune Mixed Fynbos Sub-association*	Taylor (1969)	**T. fraternus* is a conspicuous character species for this community (floristic details available in Taylor's thesis) *Erica coarctata, Cliffortia falcata, Disparago anomala, Metalasia brevifolia, Diosma hirsuta, Aspalathus forbesii, Myrica quercifolia, Struthiola salteri, Olea capensis, Asparagus stipulaceus, Chascanum cernuum, Erica coccinea, Leucadendron coniferum, Chondropetalum microcarpum* and *Thamnochortus erectus*
	Inland Dune Fynbos Sub-association	Taylor (1969)	
	and *Leucadendron coniferum* Limestone Fynbos	Boucher (1972)	
	and *Erica coarctata, Cliffortia falcata-Chondropetalum microcarpum,* and *Myrica quercifolia-Zygophyllum fulvum* communities	Milton (unpub.)	
	2. Broad-leaved littoral dune scrub communities: Coast Scrub Association, including Littoral Dune Mixed Fynbos Sub-association (on "Fernwood" sand)	Taylor (1969)	*Myrica cordifolia, Metalasia muricata, Restio eleocharis, Euclea racemosa, Passerina paleacea, Rhus glauca, Psoralea fruticans, Carpobrotus acinaciformis*
	and Coastal Dune Broad-leaved Scrub: *Arctotheca-Myrica* Strand Pioneers, and *Colpoon-Rhus* Dune Scrub	Boucher (1972)	
	and *Myrica cordifolia, Metalasia muricata-Passerina paleacea, Euclea racemosa,* and *Pterocelastrus* communities	Milton (unpub.)	
Thamnochortus pellucidus	Mixed Ericoid and Restioid Fynbos of the Xeric Seaward Slopes	Boucher (1972)	*Elegia parviflora, Staberoha cernua, Restio egregius, R. cuspidatus, Leptocarpus hyalinus, Hypodiscus aristatus, Agathelpis dubia, Gnidia pinifolia, Phaenocoma prolifera, Helichrysum sesamoides, Serruria adscendens,* and *Aspalathus aspalathoides* (the last species being recorded only from this community by Boucher)
Restio dodii	mainly Restionaceous Tussock Marsh Association, also *Berzelia-Osmitopsis* Seepage		floristic details of plots in which *R. dodii* occurred are available in Taylor's thesis (*R. dodii* var. *dodii* is restricted to the Cape of Good Hope Nature Reserve)

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SHORT COMMUNICATION

CHARACEAE: NEW FORMS AND A CHANGE IN STATUS

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Prior to the publication of Characeae in a forthcoming part of the *Flora of Southern Africa* two new forms are described and a change in status is effected.

Nitella dualis Nordst. in T. F. Allen var. **pulchella** (T. F. Allen) R.D.W. forma **obtusa** R.D.W. f. nov. a forma *pulchella* dactylis uniformibus 2-cellulatis; a forma *blowiana* (J. Groves) R.D.W. cellulis terminalibus dactyli obtusis differt.

Type: Botswana, Linyanti River, *Stephens 327* (BM, holo.!)

Differs from forma *pulchella* in having uniformly 2-celled dactyls, and from forma *blowiana* (J. Groves) R.D.W. in having the dactyl end cells obtuse.

Nitella duthiae J. Groves & Stephens forma **grovesiana** R.D.W. f. nov. a forma typica gametangiis aggregatis, radiis centralibus ramulorum secundariorum bene evolutis differt.

Type: Cape, beside causeway, Zwartkops River, near Uitenhage, *Stephens 344* (BM, holo.; BOL, iso.!)

Differs from the typical form in having aggregate gametangia and in having well-developed central secondary branchlet rays.

Chara globularis Thuill. var. **kraussii** (A.Braun ex Kütz.) R.D.W. forma **amplexa** (J. Groves & Stephens) R.D.W. stat. nov.

C. amplexa J. Groves & Stephens in Trans. R. Soc. S.Afr. **21:** 283 (1933).

Type: Cape, Cape Flats, *Rattray C5* (BM ex herb. CT, lecto.!), including vars.

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STUDIES IN THE BULBOUS LILIACEAE IN SOUTH AFRICA: 7. THE TAXONOMY OF *DRIMIA* AND CERTAIN ALLIED GENERA

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ABSTRACT

The history of taxonomic work on the South African species of *Drimia, Urginea, Litanthus, Urgineopsis, Thuranthos, Schizobasis* and *Bowiea* (Liliaceae) is outlined; the closely related *Rhadamanthus* is not dealt with. Keys to the genera and species recognised are provided. *Urginea, Urgineopsis* and *Thuranthos* are placed in synonymy under *Drimia* (23 South African species). *Litanthus* (monotypic), *Schizobasis* (2 species in South Africa) and *Bowiea* (1 species in South Africa) are also recognised. For each species a description and notes on the taxonomy, nomenclature (including synonyms and typification) and distribution are provided. Thirteen new combinations are made in *Drimia.*

UITTREKSEL

STUDIES VAN DIE BOLDRAENDE LILIACEAE IN SUID-AFRIKA: 7. DIE TAKSONOMIE VAN *DRIMIA* EN SEKERE VERWANTE GENERA

Die geskiedenis van die taksonomiese werk op die Suid-Afrikaanse soorte van *Drimia, Urginea, Litanthus, Urgineopsis, Thuranthos, Schizobasis* en *Bowiea* (Liliaceae) word geskets; die naverwante *Rhadamanthus* word nie behandel nie. Sleutels tot die genera en soorte erken word voorsien. *Urginea, Urgineopsis* en *Thuranthos* word as sinonieme onder *Drimia* (23 Suid-Afrikaanse soorte) geplaas. *Litanthus* (monotipies), *Schizobasis* (2 soorte in Suid-Afrika) en *Bowiea* (1 soort in Suid-Afrika) word ook erken. Vir elke soort word 'n beskrywing en notas oor die taksonomie, nomenklatuur (insl. sinonieme en tipes) en verspreiding voorsien. Dertien nuwe kombinasies word in *Drimia* gemaak.

INTRODUCTION

In a previous paper (Jessop, 1975) it was proposed that within the Scilleae there is a rather well-defined subgroup containing eight currently recognised genera—*Urginea, Drimia, Rhadamanthus, Litanthus, Urgineopsis, Thuranthos, Schizobasis* and *Bowiea.* The principal characters on which this group is recognised are the spurred bracts (rare in other genera), loose testa, marcescent perianth and the absence of starch in the bulb scales.

Nordenstam (1970) revised the taxonomy of the genus *Rhadamanthus* and this genus will, therefore, not be dealt with here.

The first species of this group to be validly published were two species placed in *Ornithogalum* and one species in *Hyacinthus* by Linnaeus (fil.) in 1781. The *Hyacinthus* species was transferred to *Rhadamanthus* by Salisbury in 1866.

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Although Thunberg (1794) retained Linnaeus' species in *Ornithogalum*, three closely related species, which he described, were placed in *Anthericum. Anthericum* is no longer considered to include bulbous species. Jacquin (1786–97) followed Thunberg in placing a further five species in *Anthericum*, and one in *Ornithogalum*, but he also recognised a new genus, *Drimia*, for four species which differed conspicuously in having reflexed perianth segments. Jacquin did not provide a generic description for *Drimia* which was, therefore, not validly published. Willdenow (1799) validated the name.

The species with spreading perianth segments (*Anthericum* and *Ornithogalum sensu* Jacq.) and reflexed segments (*Drimia sensu* Jacq.) have generally been kept separate from one another, but there has been much debate as to the correct generic names to assign to them. Poiret (1804) transferred three of Jacquin's species of *Anthericum* to *Phalangium* and, later (1813), transferred all of Jacquin's *Drimia* species to *Hyacinthus*. Before this date, Ker-Gawler had changed one species, which Poiret had placed in *Phalangium*, to yet another genus—*Albuca* (1805). In 1807 and 1821 Ker-Gawler transferred a further two species to *Albuca*. But one of the species in the group which Thunberg and Jacquin had called *Anthericum* was transferred (1808) to *Drimia* so that, for the first time, problems had been recognised in separating the group with spreading perianth segments (*Anthericum* of Thunberg) from that with reflexed perianth segments (*Drimia* of Jacquin).

The next major step was when Steinheil (1834) recognized that a new genus was required for some of the bulbous species within the group with spreading perianth segments to differentiate them from the quite distinct genera to which they had been attached—*Anthericum* and *Ornithogalum*. He gave the name *Urginea* to both European and South African species. *Urginea* and *Drimia* have remained the most widely accepted names for the two main groups of bulbous species with spurred bracts.

One important contribution in the mid-eighteenth century was that of Kunth (1843), who treated most species of both *Urginea* and *Drimia* as species of *Idothea*, although several of the former were included in *Ornithogalum*.

Harvey (1844) described a new genus, *Litanthus*, allied to *Urginea*, but with a well-developed oblong perianth tube. Only a single species (*L. pusillus*) has been recognized in this genus.

Hooker (1867) published Harvey's manuscript name *Bowiea*. Hooker commented that "in botanical characters (it was) allied to *Drimia* and *Scilla*". Its affinities with *Drimia* have been largely ignored since then, however. The genus has continued to be known by only one species in South Africa, although a second species was described from tropical Africa.

A further genus, attributed by the present author to this group, was described by Baker in 1873—*Schizobasis*. Baker correctly identified it as related to *Bowiea*.

In the *Flora Capensis* Baker recognised 22 species of *Drimia* of which he had described thirteen himself, and 27 species of *Urginea* of which he had described or made new combinations for all but three. In *Schizobasis* he recognised four species.

Since Baker, only two further genera have been described in this group—*Urgineopsis* and *Thuranthos*. Compton (1930) separated *Urgineopsis* from *Urginea* due to its greater degree of perianth fusion, but Adamson (1942) disagreed and placed it under *Urginea*. Wright (1916) described *Thuranthos* for a single species (*T. macranthum*) which Baker had treated as a species of *Drimia*. Dyer (1964) described a second species in *Thuranthos*.

The most recent evaluation of the generic concepts of this group is that of Mauve (in Dyer, 1976) who recognised: *Drimia* (15 South African species); *Urginea* (about 100 species from Europe, Asia and Africa, with about 40 in South Africa); *Litanthus* (endemic to South Africa, 1 species); *Rhadamanthus* (endemic to southern Africa, 9 species); *Thuranthos* (endemic to South Africa, 2 species); *Bowiea* (1 or 2 species from South Africa to tropical E. Africa) and *Schizobasis* (1 species in South Africa and further north).

TABLE 1.

Principle characters employed in separating *Urgineopsis*, *Thuranthos*, *Drimia* and *Urginea*.

Genus	Perianth reflexed	Perianth tube	Filaments	Flowers pendulous
Urgineopsis	no	distinctly fused	simple	no
Thuranthos	yes	more or less free	complex	yes
Drimia	yes	fused	simple	yes or no
Urginea	no	fused or free	simple	rarely

Rhadamanthus was regarded by Nordenstam (1970) as very close to *Urginea*, but separable because the anthers dehisce either by an apical pore or by a slit initiated at the apex. In all species of the other genera dehiscence is by a longitudinal slit. This view is accepted by the present author.

Litanthus is very readily recognisable by having one or two flowers in the inflorescence and by the perianth tube which is very much longer than the segments and more or less cylindrical.

Schizobasis is separable from *Bowiea* in being wiry rather than succulent and in having a marcescent perianth. But these two genera are very close to one another.

The position of *Urginea*, *Urgineopsis*, *Drimia* and *Thuranthos* requires re-evaluation. Table 1 indicates the principal differences.

The complex filaments of *Thuranthos* consist of a flattened basal part and terete distal part, with the filaments arching out round the ovary and connivent above. This character appears likely to be a significant one and has been greatly stressed by Dyer (1964). However, as Dyer pointed out, there is considerable similarity between the two species with this type of filament and certain other species (*U. indica* and *U. basutica*) which are generally placed in *Urginea*. The plants put into *Thuranthos* and these two species of *Urginea* form a natural group of plants, differring in size and number of flowers and in capsule shape. The two members of this group placed in *Urginea* (*U. indica* and *U. basutica*) differ from other species of *Urginea* only in having reflexed perianth segments and pendulous flowers, which are not considered sufficient grounds for separating them from *Urginea*. Therefore, in order to place these species together with *Thuranthos*, it becomes necessary to reduce *Thuranthos* to synonymy under *Urginea* or to place *U. indica* and *U. basutica* in *Thuranthos;* the former is preferred by the present author.

Urgineopsis has been dealt with by Adamson (1942). Adamson pointed out that although *Urginea* is generally considered to have free perianth segments, there are species with a degree of fusion comparable with that in *Urgineopsis*. The species mentioned by Adamson as having markedly fused perianth segments are *U. pygmaea*, *U. dregei* and *U. arenosa*. The present author considers *Urgineopsis salteri* (the only species of *Urgineopsis*) as conspecific with *Urginea tenella* (treated in this paper as a synonym for *Drimia modesta*), a species in which there is a considerable range in the fusion of the perianth.

The differences between *Urginea* and *Drimia*, when *Thuranthos* and *Urgineopsis* are included in the former, become less significant. The principal differences in the literature are the degree of fusion of the perianth, the tendency of the stamens to be connivent in *Drimia* and the reflexed perianth of *Drimia*. As stated above the degree of fusion of the perianth cannot be regarded as a generic character on its own, although *Litanthus* is partly defined on these grounds. The other two characters are present in *Urginea* too, if *Thuranthos* is included in *Urginea*. *Drimia* cannot, therefore, be separated from *Urginea*. The degree of fusion of the perianth of *Drimia* and *Urginea sensu* Baker also shows considerable overlap, and *D. anomala*, although treated as a species of *Drimia* by Baker (1897), has spreading perianth segments.

A conspicuous feature of most species of *Drimia* is the red bulb, but as this also occurs in a few species of *Urginea* (e.g. *U. maritima* and *U. sanguinea*), it cannot be regarded as a generic character. No other characters appear to be correlated with either a greater degree of fusion of the perianth or with the reflexed segments.

It is, therefore, necessary to reduce *Urginea* to synonymy under *Drimia*.

The possibility of applying to have the later generic name, *Urginea*, conserved against *Drimia* has been considered. *Urginea* is a well-known northern hemisphere genus with a species of some importance for its poisonous properties—*U. maritima*. However, in Africa *Drimia* is almost as wide-spread and well known, and the advantages of conserving the name *Urginea* do not appear to be sufficient to justify taking this step.

KEY TO THE GENERA IN THE *DRIMIA* GROUP

Aerial stem (inflorescence) simple
  Anthers opening by pores or by a slit initiated at the apex ...... **Rhadamanthus**
  Anthers opening by slits appearing simultaneously along the length of the anther
    Perianth tube long, cylindrical .... **Litanthus**
    Perianth segments free or, if fused, not forming a cylindrical tube .**Drimia**
Aerial stem (inflorescence) branched
  Aerial stem succulent. Perianth segments not adhering in fruit .... **Bowiea**
  Aerial stem wiry. Perianth segments adhering in fruit.............. **Schizobasis**

Drimia Jacq. ex Willd.

Sp. Pl. **2:** 165 (1799). (Jacq., Ic. Pl. Rar. **2** (15): tt. 373–377 (1794), Coll. suppl. pp. 38–42 (1797).).

Urginea Steinh. in Ann. Sc. Nat., ser. 2, **1:** 321 (1834). Type species: *U. fugax* Steinh.

Idothea Kunth, Enum. Pl. **4:** 342 (1843). Type species not designated.

Sypharissa Salisb., Gen. Pl. 38 (1866). Type species not designated.

Thuranthos C. H. Wright in Kew Bull. 1916: 233 (1916). Type species: *T. macranthum* (Bak.) C. H. Wright (= *Drimia macrantha* (Bak.) Jess.).

Urgineopsis Compton in J. Bot., Lond. **68:** 107 (1930). Type species: *Urgineopsis salteri* Compton (= *Drimia modesta* (Bak.) Jess.).

Bulb epigeal or hypogeal, with imbricate (not tubular) scales. *Leaves* usually hysteranthous, terete or flattened, single to many, lacking markings. *Peduncle* usually solitary, appearing terminal, unbranched, erect, bearing an elongate or capitate inflorescence. *Bract* one to each flower; spurs always present on at least the lower bracts, often early caducous, usually flattened. *Pedicels* solitary, not articulated. *Perianth segments* free or fused, similar, usually spreading or reflexed, marcescent. *Filaments* epipetalous, usually linear or linear-lanceolate. *Anthers* basifixed or dorsifixed, dehiscing longitudinally. *Ovary* sessile, usually more or less ellipsoid, with several to many ovules per locule; stigma sometimes differentiated. *Fruit* a loculicidal capsule. *Seeds* angled or flattened, with a testa that does not adhere firmly to the endosperm.

Type species: Drimia elata Jacq. ex Willd.

Species concepts in Drimia

As in other members of the bulbous Liliaceae, quantitative characters have predominated among those employed by previous authors for separating species. However, there are a few qualitative characters which have been found to be useful, and it has generally been found possible to define more clearly demarcated species than in other genera previously dealt with.

In the following discussion some of the more important features are dealt with.

(1) Bulb characters

Bulbs are very variable according to soil conditions—especially the extent of water-logging. Plants growing in wet areas tend to have much looser bulb scales and not to develop (or to retain) membranous outer scales. Qualitative differences in bulbs which have been treated by previous authors as reliable for taxonomic purposes may, therefore, be strongly influenced by environmental factors and of little practical value. In *D. altissima*, the presence of epigeal bulbs and of hypogeal bulbs is not regarded by the present author as providing sufficient grounds for subdividing this species, although it is believed to be largely independent of the environment. It was not found possible to link this bulb character with other morphological characters or with geographical distribution. On the other hand, in *D. haworthioides*, the presence of an epigeal bulb is strongly isolated geographically and it is considered justified to separate it from *D. elata* on this character.

(2) Leaf characters

There are several leaf characters which are species constant; for example whether the leaves are flat or terete. But because most species are hysteranthous, leaf characters have been avoided as far as possible in the key. The number of leaves may be diagnostic, but wide variation does occur in some species (for example *D. exuviata*).

(3) Peduncle characters

Peduncles are very variable in size and in the number of flowers which they bear and do not afford any qualitative characters.

(4) Bract characters

Bracts vary in size, but tend to be fairly constant within each of the species recognised by the present author. The spurs show a similar constancy. But neither bracts nor spurs provide qualitative characters.

(5) Perianth characters

Previous authors have laid great emphasis on the degree of fusion of perianth segments. This character has not, however, been found to be very reliable in the large *D. modesta* complex although in other species it may be more so. Whether the segments reflex or are spreading may be reliable but it is important to bear in mind that whereas *D. elata*, for example, has persistently reflexed segments, *D. macrantha* and its allies have reflexed segments only at night.

Many of the species previously placed in *Drimia* have deep pink flowers as opposed to the more drab-coloured flowers of the species placed in *Urginea*. However, these species with pink flowers do also produce a small percentage of off-white flowers and *D. anomala* only occasionally has pale pink flowers.

(6) Filament character

There is one complex qualitative character of the filaments. One species, *D. macrantha* (= *D. nocturnalis*) has a very complex filament type in which there is a constriction near the centre and a flattened part below this while the distal part is terete.

(7) Anther characters

While most species have dorsifixed anthers, a few have basifixed anthers. This character is species constant.

(8) Stigma characters

The presence or absence of a distinct stigma (usually capitate) is generally characteristic of certain species.

Key to the Species of *Drimia* in South Africa

1 Anthers basifixed.
2 Pedicels more than 20 mm long.
3 Perianth up to 20 mm long. Filaments linear-lanceolate.
4 Peduncles up to 500 mm long .... 1. **indica**
4a Peduncles at least 600 mm long .... 2. **angustifolia**
3a Perianth at least 22 mm long. Filaments terete in the distal half .... 3. **macrantha**
2a Pedicels less than 20 mm long.
5 Flowers distinctly pendulous. Leaves hysteranthous .... 7. **hyacinthoides**
5a Flowers more or less spreading to erect. Leaves synanthous.
6 Leaves usually fewer than 30, 1–2 mm broad.
7 Pedicels at least 5 mm long .... 4. **exuviata**
7a Pedicels (of flowers) less than 5 mm long .... 5. **duthieae**
6a Leaves usually more than 30, less than 1 mm broad .... 6. **multifolia**
1a Anthers dorsifixed.
8 Perianth at least 7 mm long; segments usually recurved.
9 Perianth fused, with a tube at least 20% of the length of the free segments.
10 Inflorescence a more or less globose head .... 8. **sphaerocephala**
10a Inflorescence a more or less elongate raceme.
11 Leaves usually synanthous, terete (SW Cape) .... 9. **media**
11a Leaves usually hysteranthous, flattened.
12 Bulb epigeal. Perianth tube 2–4 mm long (eastern Cape) .... 10. **haworthioides**
12a Bulb hypogeal. Perianth tube 3–7 mm long (widespread) .... 11. **elata**

9a Perianth free or with a tube less than 20 % of the length of the free segments.
13 Spur of lowest bract over 20 mm long. Leaves terete . . . 14. **macrocentra**
13a Spur of lowest bract up to 3 mm long. Leaves flattened.
14 Peduncle over 600 mm long. Bracts 5 mm or more long . . . . 13. **altissima**
14a Peduncle less than 600 mm long. Bracts 2 mm long or shorter . . . . 15. **sanguinea**
8a Perianth up to 7 mm long; segments usually spreading.
15 Inflorescence a more or less globose head.
16 Perianth segments recurved.
17 Bracts more than 6 mm long . . . . 8. **sphaerocephala**
17a Bracts less han 4 mm long . . . . 17. **marginata**
16a Perianth segments spreading . . . . 18. **depressa**
15a Inflorescence a more or less elongate raceme.
18 Bulbs with conspicuous apical bristles . . . . 19. **multisetosa**
18a Bulbs without conspicuous apical bristles.
19 Spur of lowest bract over 20 mm long.
Perianth usually over 6 mm long . . . . 14. **macrocentra**
19a Spur of lowest bract less than 10 mm long.
Perianth usually less than 6 mm long.
20 Peduncle up to 600 (rarely over 500) mm long.
21 Bracts 2 mm or more long.
22 Bulbs scales more or less white.
Peduncle 400–600 mm long. (eastern Cape) . . . . 12. **cooperi**
22a Bulb scales red or pink. Peduncle usually less than 400 mm long.
(Transvaal, Swaziland and Zululand) . 16. **delagoensis**
21a Bracts 1 mm or less long.
23 Pedicels up to 13 mm long.
24 Leaves synanthous, rigid, terete . . . 21. **anomala**
24a Leaves usually hysteranthous, fleshy, more or less flattened.
25 Spur of lowest bracts at least 2 mm long. Pedicels usually 5 mm or more long . . . . 22. **modesta**
25a Spur of lowest bracts up to 1 mm long. Pedicels usually up to 5 mm long . . . . 23. **minor**
23a Pedicels 15 mm or more long . . . . 20. **physodes**
20a Peduncle over 600 (rarely slightly under 600) mm long . . . . 13. **altissima**

1. **Drimia indica** (Roxb.) Jessop, comb. nov.

Scilla indica Roxb., Fl. Ind. **2:** 147 (1824). Type: not investigated; material from South Africa identified at Kew.

Urginea indica (Roxb.) Kunth, Enum. Pl. **4:** 333 (1843).

Urginea amboensis Bak. in Bull. Herb. Boissier, sér. 2, **3:** 665 (1903). Type: Ondonga, *Rautanen 773* (Z, holo.!).

Bulb 30–70 mm long; scales firmly packed to loose and spathulate. *Leaves* synanthous, 2–4, linear, 230–280 mm long, 4–5 mm broad, with transverse markings in purple towards the base, channelled above. *Peduncles* 280–500 mm long. *Bracts* early caducous. *Pedicels* (15–)25–30 mm long, spreading. *Perianth* pale brown with flesh-coloured margins, fused for *c*.1 mm, 9–12 mm long, reflexed. *Filaments* erect, connivent above the ovary, *c*.7 mm long, linear-lanceolate, tapering uniformly from the base, attached towards the base of the perianth; anthers basifixed, green, 3–4 mm long. *Ovary* ovoid, *c*.3,5 mm long, green; style *c*.6,5 mm long, capitate, subtruncate apically, 3-lobed. *Capsule* oblong ovoid, 16–25 mm long. *Seed* flat, elliptic to orbicular, 8–10 mm long.

D. indica occurs from Asia, through tropical Africa, and into the extreme northern South West Africa and, in the east, into the lowveld of the Transvaal and Zululand.

Occurs in grassveld. Flowers have been recorded in November. They open at night and emit a foetid smell.

This species belongs, on overall characters, to the group which includes also the following two species. On filament characters it is closest to *D. angustifolia* but can be separated on its longer, narrow leaves and smaller peduncles, bracts, pedicels and flowers. *Moll 4309*, from Ndumu Game Reserve (PRE), is atypical in having shorter pedicels (7 mm), but this may be a result of the younger age of the inflorescence.

The specimen from South West Africa (*Davies, Thompson & Miller 54* (PRE), from the Cunene Gorge) is in fruit, but appears to be a good match. The only other specimens seen from South West Africa are Rautanen collections from Ondonga.

The taxonomy and typification of this species has not been investigated in detail. But examination of a range of material at Kew suggests that the material from southern Africa is conspecific with Asian and tropical African material.

SELECTED SPECIMENS

SOUTH WEST AFRICA—1714 (Ruacana Falls): Cunene Gorge, *Davies, Thompson & Miller 54* (PRE).

TRANSVAAL—2431 (Acornhoek): Kruger National Park, E. of Muntshe Hill and Mlondozi Dam, *Mauve 4823* (PRE).

NATAL—2632 (Bella Vista): Ndumu Game Reserve, *Moll 4432* (PRE); Ndumu Hill, *Pooley 127* (NU).

2. **Drimia angustifolia** Bak. in Fl. Cap. **6:** 440 (1897).

Lectotype: Cape, Tarka, *Cooper 387* (K, lecto.!). Syntypes: Cape, Boschberg, *Tuck s.n.* sub *MacOwan 2211* (K!); Natal, Colenso, *Wood 4027* (K!, BOL!). *Tuck s.n.* sub *MacOwan 1835* (BOL! & GRA!) are of this concept of *D. angustifolia* and may be isolectotype material.

Urginea basutica Phill. in Ann. S. Afr. Mus. **16:** 306 (1917). Type: Lesotho, Leribe, *Dieterlen 854a* (PRE, holo.!, K!).

Bulb (30–)35–65(–75) mm long, 55 mm broad; scales firmly packed to loose and spathulate, whitish, globose to ellipsoid. *Leaves* usually hysteranthous, about 3 to a bulb, linear, 55–160 mm long, 7–13 mm broad, channelled on the face. *Peduncle* 600–900 mm long, with 4–9 flowers very laxly arranged. *Bracts* 7–8 mm long; the lowest early caducous. *Pedicels* (35–)50–60(–80) mm long, spreading in flower, ascending in fruit and becoming very much thickened. *Perianth* varying in colour from yellow-green to brownish-white, fused for up to 1–4 mm, 14–20 mm long, reflexed. *Filaments* erect, attached 2,5–4 mm above base of perianth, linear-lanceolate, 7–11 mm long; anthers green, 2,5–7 mm long, connivent, basifixed. *Ovary* narrowly obovoid, 5–8 mm long; style 6,5–9 mm long, clavate at first, expanding to subcapitate to 3-angled, subtruncate. *Capsule* oblong-obovoid to oblong, 25–40 mm long. *Seeds* flat, ellipsoid to obovate, sometimes asymmetrical, 9–10 × 5–7 mm.

Widespread in the eastern half of South Africa, including much of the Transvaal, the Orange Free State, Lesotho, the north-western Natal and the eastern parts of the Cape.

The habitat of *D. angustifolia* is extremely variable. Records include dry localities, such as stony koppies, but also wetter localities including "black soil along a stream" and even in marshy areas. Flowers are produced in early summer—October to December—and there is a single record for May. It is likely, but not certain, that the flowers only open at night.

In distribution, there is some overlap between this species and *D. macrantha*. Superficially, there is also a great deal of similarity despite the overall greater size of the latter. And the two are probably best separated on filament form. In the opinion of the present author, the possibility that further material may not support the separation of these two species should not be ignored.

SELECTED SPECIMENS

TRANSVAAL—2329 (Pietersburg): Carlisle, near Blaauwberg Mtn, *De Winter 7163* (PRE).
—2528 (Pretoria): Willow Glen, *Strey 3925* (PRE).
—2529 (Witbank): 4 miles N. of Stofberg, *Mauve 4088* (PRE).
—2628 (Johannesburg): between Leslie and Devon, *Dyer 4181* (PRE).
ORANGE FREE STATE—2925 (Jagersfontein): Groenvlei, Fauresmith, *Kies 332* (PRE).
—2926 (Bloemfontein): near Eagle's Nest, Bloemfontein, *Potts s.n.* sub BLFU *1525* (BOL).
LESOTHO—2828 (Bethlehem): Leribe, *Dieterlen 854* (GRA, P, PRE, SAM).
NATAL—2829 (Harrismith): near Colenso, *Wood 4027* (BOL).
CAPE—2824 (Kimberley): Warrenton, *Acocks 1603* (PRE).
—3225 (Somerset East): Bester's Hoek, near Somerset East, *MacOwan 1835* (BOL, GRA).

3. **Drimia macrantha** (Bak.) Bak. in Engl. Bot. Jahrb. **15** (3) : 7 (1892).

Ornithogalum macranthum Bak. in J. Linn. Soc., Bot. **13:** 280 (1873). Type: "Cap. B. Spei," *Drège 2204* (BM, lecto.!, G!, L!).

Thuranthos macranthum (Bak.) C. H. Wright in Kew Bull. **1916:** 233 (1916).

Urginea macrantha (Bak.) Phill. in Ann. S. Afr. Mus. **16:** 305 (1917).

Thuranthos nocturnale R. A. Dyer in Flower. Pl. Afr. **36:** t.1439 (1964). Type: Cape, Grootfontein, *Acocks 18650* (PRE, holo.!).

Bulb 30–100 mm long, ovoid to globose; scales loose, spathulate to distinctly pedicellate. *Leaves* hysteranthous, 2–4, linear, (130)–420–600 mm long, 6–10 mm broad, channelled. *Peduncles* 300–1 300 mm long, with 12–30 flowers. *Bracts* 3–7 mm long, early caducous. *Pedicels* (33–)40–50 mm long, spreading. *Perianth* varying in colour from green to brown, if brown often with a green keel and margin, fused for 1–2 mm, (22–)28–33 mm long, reflexed at night. *Filaments* erect, connivent above the ovary, with the flat proximal part 6–12 mm long and the terete distal part 4–7 mm long; anthers basifixed, green, 3,5–5 mm long. *Ovary* ovoid to oblong, 4–5 mm long; style 14–22 mm long, capitate, subtruncate. *Capsule* oblong to ellipsoid, usually deeply 3-lobed, 25–40 mm long. *Seeds* flat, broadly elliptic, 6–14 mm long.

D. macrantha has only been recorded from the eastern Cape. It has been recorded from both the Karoo and from grassveld, with a single record from bush country. Soil conditions vary considerably. In dry areas it has been commonly found on sandy slopes but in damper areas it occurs on heavy turfs. It often grows in clumps. The flowers are produced during summer and open in the evening. A sweet scent has been reported.

This species belongs in the group with *D. indica* and *D. angustifolia*. Dyer (1964) distinguished *Thuranthos nocturnale* which he believed to be smaller and distinguishable by the shape of the leaves, stigma and capsule. There is, however, insufficient material of either leaves or capsules to make a detailed evaluation of these two characters and available evidence suggests that *T. nocturnale* is the dry area form of *D. macrantha*. These two forms are linked by a continuous range of intermediates for all characters for which there is sufficient material to judge.

For illustration see Flower. Pl. Afr. **36:** t.1439 (1964).

SELECTED SPECIMENS

CAPE—2823 (Griekwastad): Postmasburg, near Pretorius Vlei, *Pretorius s.n.* (PRE).
—3124 (Hanover): Wildfontein Station, *Acocks 16245* (PRE).
—3125 (Steynsburg): Grootfontein, *Acocks 18650* (PRE).
—3225 (Somerset East): Klyn Bruintjeshoogte, *MacOwan 1848* (SAM).
—3226 (Fort Beaufort): Tarka River, *Cooper 387* (TCD).

—3227 (Stutterheim): East London, upper end of Second Creek, *Dodd s.n.* sub *Galpin 7962* (PRE); near Komgha, *Flanagan 468* (BOL, GRA, K, PRE, SAM, Z).
—3228 (Butterworth): Kentani, *Pegler 79* (K, NU, PRE).
—3325 (Port Elizabeth): Baakens River Valley, *Archibald s.n.* (PRE).
—3326 (Grahamstown): Alicedale, *Cruden 211* (GRA).

4. **Drimia exuviata** (Jacq.) Jessop, comb. nov.

Anthericum exuviatum Jacq., Icones **2** (13): 18, t.415 (1794). Type: Jacq., Icones **2** (13): t.415 (1794).

Phalangium exuviatum (Jacq.) Poir., Encyc. **5:** 243 (1804).

Albuca exuviata (Jacq.) Ker-Gawl. in Curtis's bot. Mag. **22:** t.871 (1805).

Urginea exuviata (Jacq.) Steinh. in Ann. Sc. Nat., sér. 2, **2:** 330 (1834).

Ornithogalum exuviatum (Jacq.) Kunth, Enum. Pl. **4:** 369 (1843).

Sypharissa exuviata (Jacq.) Salisb., Gen. 38 (1866), comb. valid. non.

Anthericum filifolium Jacq., Icones **2** (15): 18, t.414 (1794). Type: Jacq., Icones **2** (15): t.414 (1794), possibly antedated by *A. filifolium* Thunb.

Phalangium filifolium (Jacq.) Poir., Encyc. **5:** 242 (1804).

Albuca filifolia (Jacq.) Ker-Gawl. in Bot. Reg. **7:** 557 (1821).

Urginea filifolia (Jacq.) Steinh. in Annls Sci. nat., sér. 2, **2:** 329 (1834).

Ornithogalum filifolium (Jacq.) Kunth, Enum. Pl. **4:** 369 (1843).

Sypharissa filifolia (Jacq.) Salisb., Gen. 38 (1866), comb. valid. non.

Anthericum spiratum Thunb., Prodr. 62 (1794). Type: "Cap. b. spei", *Thunberg s.n.* (UPS—*8413* and *8414*, microfiche!).

Anthericum fragrans Jacq., Hort. Schoenbr. **1:** 45, t.86 (1797). Type: Jacq., Hort. Schoenbr. **1:** t.86 (1797).

Phalangium fragrans (Jacq.) Poir., Encyc. **5:** 247 (1804).

Albuca fugax Ker-Gawl. in Bot. Reg. **4:** t.311 (1818), nom. nov. for *Anthericum fragrans* Jacq.

Urginea fragrans (Jacq.) Steinh. in Annls Sci. nat., sér. 2, **2:** 328 (1834).

Ornithogalum fragrans (Jacq.) Kunth, Enum. Pl. **4:** 366 (1843).

Sypharissa fragrans (Jacq.) Salisb., Gen. 38 (1866), comb. valid. non.

Urginea unifolia Duthie in Ann. Univ. Stell. **6A** (2): 8–9 (1928). Type: Stellenbosch Flats, *Duthie s.n.* sub STE *1891* (STE, holo.!).

Urginea flexuosa Adamson in Jl S. Afr. Bot. **8:** 240–241 (1942). Type: Cape Peninsula, Smitswinkel Bay, *Adamson 3099* (BOL, holo.!).

Bulb (20–)35–70 mm long, ovoid, usually solitary, characteristically with a few raised dark coloured transverse bars on the upper parts of the ensheathing neck of the bulb, sometimes with the scales very loosely arranged. *Leaves* synanthous, 1–10(–35), narrowly linear to terete, often spirally twisted, (150–) 200–350(–400) mm long, 1–2(–3) mm broad. *Peduncle* (120–)220–400(–600) mm long, with (10–)15–60 flowers. *Bracts* 2–7 mm long, sometimes auriculate; lowest spurs 4–9(–15) mm long. *Pedicels* 6–13 mm long, erect-spreading to ascending. *Perianth* white or greenish-white, sometimes mauve below, usually with a purple or green dorsal stripe (vein), fused for 1–1,5 mm, 8–12(–15) mm long; the segments linear-oblong to elliptic or slightly broader in the proximal half, rarely up to 7 mm broad, spreading or, less often, somewhat reflexed. *Filaments* 3–6 mm long, linear; anthers basifixed, 2–6 mm long, usually connivent. *Ovary* oblong-ellipsoid, 2,5–5 mm long; style 3–9 mm long; stigma minutely 3-lobed. *Capsule* ellipsoid, 8–13 mm long. *Seeds* flat, elliptic, 4–7 × 3–4 mm.

D. exuviata is widespread in the western Cape and extending into the eastern Cape as far as Grahamstown.

Occurs in areas differing widely in rainfall from the Richtersveld to the mountains of the south-western Cape with rainfalls from probably under 100 mm p.a. to over 2 000 mm. It has been recorded from lime soils but also from sandy flats and from mountain slopes derived from Table Mountain Sandstone. Flowers are produced from September throughout summer. The flowers are scented.

The transverse bars on the upper parts of the bulb scales are highly characteristic, although an occasional specimen lacks them. In *Hutchinson 301*, from near Saldanha Bay (PRE), the distal membranous portion of the bulb scales is exceptionally long, being nearly 200 mm in length, with over 20 bars to the scale.

Flowers are generally readily recognised as belonging to a member of this group (with *D. duthieae* and *D. multifolia*) because of the conspicuous dorsal stripe on the perianth segments. In a few specimens the style is declinate (e.g. *Leipoldt s.n.* sub NBG *73218*), but this character presents difficulty in its identification as it appears in only a few flowers in each inflorescence and appears to be a temporary phenomenon associated with a particular stage in the development of the flower. This is a characteristic of *D. multifolia*, but has not been observed in *D. duthieae*.

For illustration see Kidd, M. M. (1950), *Wild flowers of the Cape Peninsula*, pl. 71, fig. 4 and pl. 10, fig. 4.

SELECTED SPECIMENS

CAPE—2917 (Springbok): Steinkopf, *Meyer s.n.* sub *Marloth 13320* (PRE).
—3018 (Kamiesberg): Khamiesberg, *Esterhuysen 23724* (BOL).
—3118 (Vanrhynsdorp): Giftberg, *Hall 3906* (NBG).
—3119 (Calvinia): Nieuwoudtville, *Galpin 10509* (PRE).
—3217 (Vredenburg): north of Saldanha Bay, *Hutchinson 301* (BOL, GRA, PRE).
—3218 (Clanwilliam): De Hoek, *Compton 14992* (NBG).
—3219 (Wuppertal): Middelberg, *Esterhuysen 7225* (BOL).
—3317 (Saldanha): Kreeftebaai, *Rourke 587* (NBG).
—3318 (Cape Town): Stellenbosch Flats, *Duthie s.n.* sub STE *1891* (BOL, STE).
—3319 (Worcester): Michells Pass, *Esterhuysen 20723* (BOL, PRE).
—3320 (Montagu): Donkerkloof, *Compton 18492* (NBG).

—3321 (Ladismith): Muiskraal Vlei near Garcias Pass, *Galpin 4747* (K, PRE).
—3325 (Port Elizabeth): Port Elizabeth, *Drège 294* (GRA).
—3326 (Grahamstown): Rockcliffe, near Sidbury, *Daly 803* (GRA, PRE).
—3418 (Simonstown): Claremont, *Schlechter 446* (P).
—3419 (Caledon): Bot River, *Van Niekerk 651* (K, PRE).
—3420 (Bredasdorp): Bontebok Park, Bredasdorp, *Martin 584* (NBG).

5. **Drimia duthieae** (Adamson) Jessop, comb. nov.

Urginea duthieae Adamson in Jl S. Afr. Bot. **8:** 239 (1942). Type: Stellenbosch Flats, *Duthie s.n.* sub STE *1790* (STE, holo.!, K!); nom. nov. for *Urginea ecklonii sensu* Duthie in Ann. Univ. Stell. **6A** (2): 6 (1928), non Bak.

Bulb ovoid to globose, 10–15 mm long. *Leaves* synanthous, solitary, terete, 150–250 mm long. *Peduncles* 130–220 mm long, with 3–8 flowers in a more or less capitate arrangement. *Bracts* 3–4 mm long; lowest bracts with spurs up to 6 mm long. *Pedicels* 2–4 mm long, spreading to ascending. *Perianth* white with a green or brown dorsal stripe, fused for less than 1 mm, 7–8 mm long, ovate to elliptic, spreading. *Filaments* sublinear, *c*.5 mm long; anthers basifixed, *c*.1,5 mm long, probably connivent. *Ovary* ellipsoid, 4–5 mm long; style 2–3 mm long; stigma minutely 3-lobed. *Capsule* ovoid, 5–11 mm long.

Restricted to the Stellenbosch-Cape Peninsula area of the south-western Cape.

Habitat recorded as ironstone flats. Flowers are produced in October and November, but their time of opening and whether or not they are scented does not appear to have been recorded.

The basifixed anthers and dorsal stripe to the perianth segments indicates a very close relationship with *D. exuviata*. It is almost entirely on size that they are separated (with some hesitation) and on the slightly capitate inflorescence.

SELECTED SPECIMENS

CAPE—3318 (Cape Town): N'Dabeni, *Salter 8698* (BOL, NBG, SAM); *Adamson 3270* (K, PRE, SAM); Stellenbosch Flats, *Duthie s.n.* (BOL); *Duthie s.n.* sub STE *1790* (K, STE, STE-U).

6. **Drimia multifolia** (G. J. Lewis) Jessop, comb. nov.

Urginea multifolia G. J. Lewis in Ann. S. Afr. Mus. **40:** 9 (1952). Type: 27 miles south of Springbok, *Lewis 2302* (SAM, holo.!).

Bulb 20–40 mm long, ellipsoid to globose, with whitish scales; outer membranous scales of herbarium material often pink distally, forming a 1-scaled sheath around the leaves with transverse barring. *Leaves* synanthous, (30–) 40–50, terete, often spirally twisted, *c*.100–200 mm long, *c*.0,2 mm broad. *Peduncles* 50–200 mm long, with *c*.10–15 flowers. *Bracts* 1,5–2(–4) mm long; the lowest with spurs up to 5 mm long. *Pedicels* 4–8 mm long, erect-spreading. *Perianth* white, often pinkish on the dorsal surface, with a very prominent green or brown-purple vein, fused for less than 1 mm, 10–12 mm long; segments ellipsoid, 4–5 mm broad. *Filaments* 4–5 mm long, linear-lanceolate; anthers basifixed, *c*.3 mm long. *Ovary* oblong-ellipsoid, *c*.4 mm long; style 3 mm long, often declinate; stigma slightly 3-lobed. *Fruit* unknown.

Recorded from the western Cape, especially from Namaqualand and the extreme western Karoo.

Occurs in dry areas, but virtually nothing has been recorded of its habitat or field characters. Flowers are sweet scented.

This species is very close to *D. exuviata,* with similarly barred bulb scales and perianth segments with prominent dorsal stripe. The declinate style has also, but not so frequently, been recorded in that species. The large number of leaves, although not entirely satisfactory, is the principal character for separating these species.

For illustration see Ann. S. Afr. Mus. **40:** 9 (1952).

SELECTED SPECIMENS

CAPE—2917 (Springbok): Springbok, *Van Heerde s.n.* (BOL); 8½ miles S.W. of Springbok, *Acocks 19563* (K, PRE).

—3017 (Hondeklipbaai): I'Aus, *Schlechter 11222* (GRA, PRE); 27 miles S. of Springbok, *Barker 6310* (NBG).

—3018 (Kamiesberg): De Kom (now farm Karas), 3 miles from Leliefontein in the Khamiesbergen, *Leipoldt 3378* (BOL).

—3119 (Calvinia): between Oorlogskloof and Papkuilsfontein, *Leipoldt s.n.* (BOL); Menzieskraal, near Nieuwoudtville, *Markotter s.n.* sub STE-U *18989* (STE).

—3220 (Sutherland): 20 miles N.E. of Sutherland, *Acocks 17204* (PRE).

7. **Drimia hyacinthoides** Bak. in J. Bot., Lond. **1874:** 6–7 (1874). Type: Cape, Woest Hill, near Grahamstown, *MacOwan 1465* (GRA, lecto.!, K!).

Bulb *c*.60 mm long, more or less globose; scales very loose, probably sometimes reddish but more often white. *Leaves* hysteranthous, few, linear to oblong, 100–120 mm long, 14–24 mm broad, glabrous. *Peduncles* 200–500(–700 in fruit) mm long, with (20–)30–40(–50) flowers. *Bracts* 3–4 mm long; lowest spurs 3–6(–8) mm long. *Pedicels* lilac or greyish-mauve coloured with a white dorsal stripe, fused for *c*.1–2 mm, 9–12 mm long; the flowers pendulous, linear-campanulate. *Filaments* linear, connivent above the ovary, *c*.2,5 mm long; anthers basifixed, 2,5–3 mm long. *Ovary* globose to ovoid, 3–4 mm long; style 4–5 mm long, capitate. *Capsule* ellipsoid, 7–12(–16) mm long. *Seeds* flat, rather irregular in outline, 6–7 × 2–4 mm.

Recorded only from a small part of the eastern Cape, including Alexandria, Fort Beaufort and near East London.

Occurs in grassveld, sometimes in the shelter of bushes, and sometimes in what Acocks (1953) called "False Karroid Broken Veld". No scent has been recorded.

The affinities of this group are not clear. In some ways the shape of the flower is reminiscent of *Rhadamanthus* rather than of *Drimia*, but there are no other characters linking it with that genus and the anthers dehisce longitudinally. Within *Drimia* there are few species with basifixed anthers and, if this is an important character, it suggests a relationship with the *D. macrantha* group, but again there are no further reasons for linking it to that group except, perhaps, the pendulous flowers. It must, therefore, be concluded that this species is rather isolated.

For illustration see Batten, A. & Bokelmann, H. (1966), *Wild flowers of the eastern Cape*, pl. 11, fig. 5.

SELECTED SPECIMENS

CAPE—3226 (Fort Beaufort): Fort Beaufort, Kromo Mouth Trig. Beacon, *Acocks 20106* (PRE).

—3227 (Stutterheim): Nahoon River, *Wood s.n.* sub *Galpin 3152* (BOL, PRE); Slippery Drift, *Smith s.n.* sub NBG *77375* (NBG).

—3326 (Grahamstown): between Kap River and Trapps Valley, *Dyer 3390* (PRE); 7 miles from Grahamstown on Gletwyn, *Dyer 3306* (BOL, PRE); Alexandria, near Bushmans River Pont, *Archibald 6137* (PRE).

8. **Drimia sphaerocephala** Bak. in Fl. Cap. **6:** 441 (1897). Type: Transvaal, Concession Creek near Barberton, *Galpin 1020* (K, lecto.!, BOL!, SAM!).

Drimia neriniformis Bak. in Fl. Cap. **6:** 442 (1897). Type: Natal, Van Reenen, *Wood 4794* (K, lecto.!, NH!, P!, PRE!, Z!).

Drimia capitata Bak. in Fl. Cap. **6:** 442 (1897). Lectotype: Cape, Bazeia, *Baur 1160* (K!). Syntype: Orange Free State, *Cooper 885* (K!).

Bulb 20–30(–40) mm long, ovoid to subglobose; scales often rather loose, pale coloured (yellowish rather than pink in herbarium material). *Leaves* usually hysteranthous, usually *c*.3–4, linear, acute, 115–170 mm long, 6–8 mm broad, ciliate on the margins. *Peduncles* (200–)300–500(–700) mm long, with 15–20 flowers in a capitate arrangement. *Bracts* 6–9 mm long; lowest spurs 3–12 mm long. *Pedicels* (3–)7–10(–20) mm long, erect-spreading to spreading. *Perianth* very variable in colour (white, pink, mauve, greenish yellow, or light green) but usually white, fused for (1–)2–3(–5) mm, (6–)8–12(–15) mm long, reflexed. *Filaments* greenish or white, 4–8(–10) mm long, linear; anthers green, dorsifixed, 1–1,5 mm long. *Ovary* ellipsoid to ovoid, 1,5–3 mm long; style 4,5–9 mm long, capitate. *Capsule* ellipsoid, 7–8 mm long.

Presently known from most of the Transvaal, Swaziland, Lesotho, Natal and the extreme eastern part of the Orange Free State. A single record also exists for the Cape (excluding the type of *D. capitata*).

The most frequent habitat records suggest a strong preference for damp areas—"black turf grassveld near stream", marshy ground and shallow wet sandy soil being reported. Other records indicate, however, that it does also occur in drier grassveld, especially on slopes.

Although most species formerly placed in *Drimia* had reddish bulbs, this species, because of its fused and reflexed perianth segments was also placed there. A single specimen (*Devenish 257* from Oshoek; PRE) is atypical in having a distinctly red bulb—but it is possible that this specimen may be a hybrid with *D. elata*.

Baker (1897) separated *D. capitata* from *D. sphaerocephala* and *D. neriniformis* on the length of the pedicels, and *D. neriniformis* from *D. sphaerocephala* on the diameter of the heads. Fig. 1 indicates the lack of correlation between these characters and the difficulty encountered in trying to apply Baker's criteria.

Selected Specimens

TRANSVAAL—2230 (Messina): Messina, *Moss & Rogers 1396* (BOL).
—2328 (Baltimore): Blaauwberg, *Esterhuysen 21424* (BOL).
—2430 (Pilgrim's Rest): The Downs, *Rogers 22043* (Z); Graskop, *Galpin 14655* (PRE).

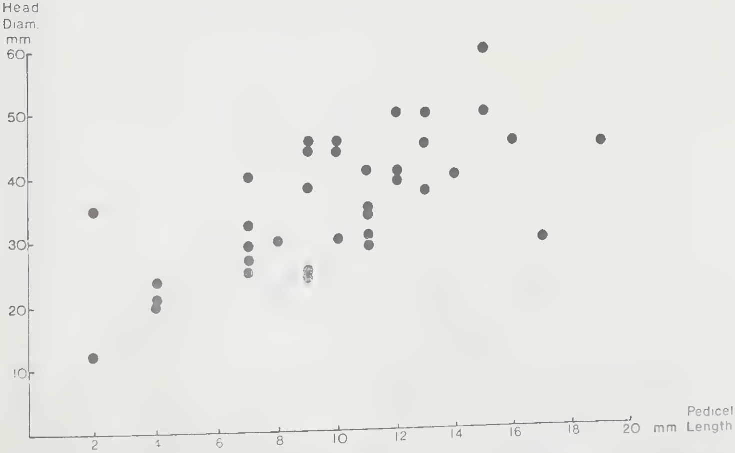

Fig. 1.

Diagram to illustrate variation in diameter of flowering head and length of pedicel in *Drimia sphaerocephala*. Based on herbarium specimens.

—2530 (Lydenburg): Dullstroom, *Galpin 13043* (PRE); Mount Anderson, *Smuts & Gillett 2417* (PRE); Belfast, *Pole Evans s.n.* (PRE).
—2531 (Komatipoort): Back of Concession Creek, *Galpin 1020* (BOL, SAM).
—2629 (Bethal): Spitskop, *Pott s.n.* sub Tvl Mus. *15238* (PRE).
—2730 (Vryheid): Oshoek, *Devenish 257* (PRE).
SWAZILAND—2631 (Mbabane): Forbes Reef Road, *Compton 30265* (NBG, PRE).
ORANGE FREE STATE—2828 (Bethlehem): Besters Vlei, *Flanagan 1934* (PRE).
—2829 (Harrismith): Rensburgskop, *Jacobsz 294* (PRE).
LESOTHO—Lithayaneng, Leribe, *Dieterlen 741* (P, PRE, SAM).
NATAL—2828 (Bethlehem): Royal Natal National Park, *Trauseld 95* (PRE).
—2829 (Harrismith): Van Reenen, *Wood 5860* (PRE).
—2929 (Underberg): Giants Castle Game Reserve, *Skead 59* (NU).
—3029 (Kokstad): Weza, Alfred, *Strey 6371* (PRE).
—3030 (Port Shepstone): Highflats, *Shirley 319* (NU).
CAPE—St Bernards, Griqualand East, *Barker 7977* (NBG).

9. **Drimia media** Jacq. ex Willd., Sp. Plant. **2:** 166 (1799). Type: Jacq., Icones **2** (16): t.375 (1795).

Drimia media Jacq. (nom. invalid.), Icones **2** (16): 15, t.375 (1795); generic name not validly published.

Hyacinthus medius (Jacq. ex Willd.) Poir., Encyc., Suppl. **3:** 120 (1813).

Idothea media (Jacq. ex Willd.) Kunth, Enum. Pl. **4:** 343 (1843).

Bulb (30–)35–60(–95) mm long, ovoid; scales tightly packed, red. *Leaves* usually synanthous, but often poorly developed at anthesis and rarely only slightly in evidence at anthesis, 3–10(–20), hard, rigid, terete, 80–150(–400 usually only after anthesis) mm long, 1,5–4 mm broad. *Peduncles* (300–)350–450(–600) mm long, with 20–35 flowers in an elongate raceme. *Bracts* 1–2,5 mm long; the lowest with a spur 1–1,5 mm long, but early caducous. *Pedicels* (5–)8–9(–10) mm long, spreading or erect-spreading. *Perianth* dull purplish, fused for 3–4,5 mm, 10–13(–16) mm long; segments reflexed in daylight. *Filaments* attached at mouth of perianth, linear-lanceolate, tapering slightly from the base, *c*.6 mm long, white; anthers dorsifixed, 0,75–2 mm long. *Ovary* ovoid, 2–3 mm long; style 6–8 mm long, capitate, 3-lobed. *Capsule* oblong to obovoid, 9–11 mm long. *Seeds* somewhat flattened, narrowly ellipsoid, 6–7 mm long.

Occurs in the south-western Cape from the Cape Peninsula and Saldanha Bay along the southern coast to Knysna.

Common and occurring in most of the principal habitats along the narrow coastbelt. Grows in the sand close to the sea, but also on mountain slopes. The flowers do not open only at night.

D. media is closely related to *D. elata*. The only way in which it can be separated is by its synanthous terete hard leaves. Hysteranthous plants can, with a very high degree of certainty, be placed in *D. elata*.

For illustration see Kidd, M. M. (1950), *Wild flowers of the Cape Peninsula*, pl. 9, fig. 9.

SELECTED SPECIMENS

CAPE—3217 (Vredenburg): Saldanha Bay, *Marloth 7956* (PRE).
—3318 (Cape Town): Camps Bay, Lower Blinkwater, *Cassidy 148* (NBG).
—3319 (Worcester): Great Drakenstein, *Esterhuysen 21348* (BOL); Klaasvoogds, *Esterhuysen 22711a* (BOL).
—3418 (Simonstown): Klaver Valley, *Salter 5930* (BOL); foot of Sir Lowrys Pass, *Stokoe s.n.* sub SAM *65755* (SAM).
—3419 (Caledon): Vogelgat, *Schlechter 10404* (BOL, GRA, L, P, PRE).
—3421 (Riversdale): Gouritz River Bridge, *Hall 971* (NBG).
—3422 (Mossel Bay): Belvedere, *Duthie 773* (BOL, GRA).
—3423 (Knysna): Knysna, *Breyer s.n.* sub Tvl Mus. *23581* (PRE).
"Cape," *Drège 1496* (L, P).

10. **Drimia haworthioides** Bak. in Gdnrs' Chron. 1875, **3:** 366 (1875). Type: near Graaff-Reinet, *Bolus 40* (K, holo.!).

Bulb epigeal, *c*.20–30 mm long; scales loose, pedicellate, purplish-grey. *Leaves* usually hysteranthous, rarely exceeding 10, lanceolate, usually ciliate on the margins, 60–80 mm long, 10–15 mm broad. *Peduncles* 200–400 mm long, with 15–30 flowers. *Bracts* 1–4 mm long; spur of lowest bracts *c*.1 mm long, early caducous. *Pedicels* 3–8 mm long, erect-spreading. *Perianth* greenish or greenish-brown, 10–15 mm long, fused for 2–4 mm; segments reflexed. *Filaments* *c*.7 mm long, linear, sometimes (?always) mauve; anthers dorsifixed, *c*.1 mm long; style 5–7 mm long, capitate. *Capsule* ellipsoid, 7–10 mm long. *Seeds* unknown.

Restricted to a small part of the eastern Cape, including Graaff-Reinet, Humansdorp and Grahamstown.

Occurs in grassveld, sometimes among rocks.

The aerial parts are similar to those of *D. elata* although generally with fewer flowers. The pedicellate bulb scales are the only apparently reliable way of distinguishing these species.

Two secimens from outside the accepted range of *D. haworthioides* require comment. *Wisura 1382* (NBG), from 14 miles W. on Witteberg road, about 3 miles S. of Laingsburg, has loose scales but probably not as loose as in *D. haworthioides*, ciliate hysteranthous leaves measuring 130–160 × 11–13 mm, and a similar perianth although the segments are a little narrower. The bulb scales are red. *Salter s.n.* sub NBG *1193/37* (BOL), from 10 miles W. of Ladismith (Cape), is similar but lacks a bulb. Both flower in summer, as in *D. haworthioides.* Further information is needed to determine the position of these two plants and they have not been allocated to a species in the present work.

SELECTED SPECIMENS

CAPE—3224 (Graaff-Reinet): Graaff-Reinet, *Francis 56* (BOL).
—3325 (Port Elizabeth): Loerie, *Dix 186* (GRA); Zwartkops River, *Zeyher 520* (SAM).
—3326 (Grahamstown): Alicedale, *Cruden 182* (GRA); Gletwyn, *Dyer 3372* (PRE); Port Alfred, *Rogers s.n.* sub GRA *1685* (BOL, GRA).
—3424 (Humansdorp): Jeffreys Bay, *Duthie s.n.* sub *Fourcade 3295* (Fourcade collection, BOL).

11. **Drimia elata** Jacq. ex Willd., Sp. Plant. **2:** 165 (1799). Type: Jacq., Icones **2** (15): t.373 (1794).

Drimia elata Jacq. (nom. invalid.), Icones **2** (15): 15, t.373 (1794); generic name not validly published.

Hyacinthus elatus (Jacq. ex Willd.) Poir., Encyc., Suppl. **3:** 120 (1813).

Idothea elata (Jacq. ex Willd.) Kunth, Enum. Pl. **4:** 343 (1843).

Drimia pusilla Jacq. (nom. invalid.), Icones **2** (14): 15, t.374 (1794); generic name not validly published.

Drimia pusilla Jacq. ex Willd., Sp. Plant. **2:** 165 (1799). Type: Jacq., Icones **2** (14): t.374 (1794).

Hyacinthus pusillus (Jacq. ex Willd.) Poir., Encyc., Suppl. **3:** 120 (1813).

Idothea pusilla (Jacq. ex Willd.) Kunth., Enum. Plant. **4:** 344 (1843).

Drimia ciliaris Jacq. (nom. invalid.), Icones **2** (16): 15, t.377 (1795).

Drimia ciliaris Jacq. ex Willd., Sp. Plant. **2:** 165 (1799). Type: Jacq., Icones **2** (16): t.377 (1794).

Hyacinthis ciliaris (Jacq. ex Willd.) Poir., Encyc., Suppl. **3:** 120 (1813).

Idothea ciliaris (Jacq. ex Willd.) Kunth, Enum. Pl. **4:** 343 (1843).

Drimia purpurascens Jacq.f., Eclog. 48, t.30 (1812). Type: Jacq.f., Eclog. 48, t.30 (1812).

Idothea purpurascens (Jacq.f.) Kunth, Enum. Pl. **4:** 342 (1843).

Drimia villosa Lindl. in Bot. Reg. **16:** t.1346 (1830). Type: "received from Mr Tate from the Cape", Bot. Reg. **16:** t.1346 (1830).

Idothea villosa (Lindl.) Kunth, Enum. Pl. **4:** 343 (1843).

Idothea humilis Bergius ex Kunth, Enum. Pl. **4:** 344 (1843). Type: not known.

Drimia altissima Hook.f. in Curtis's bot. Mag. **91:** t.5522 (1865), nom. illegit., non L.f. Type: origin not known (K, holo.!).

Drimia alta R. A. Dyer in Flower. Pl. S. Afr. **23:** t.890 (1943), nom. nov. for *Drimia altissima* Hook.f.

Drimia robusta Bak. in Saund., Ref. Bot. **3:** t.190 (1870). Type: "Cape Colony from Cooper," Hort Saunders 4404 (K, holo.!).

Idothea robusta (Bak.) Kuntze, Rev. Gen. **2:** 712 (1891).

Drimia burchellii Bak. in Saund., Ref. Bot. **3,** app. 2 (1870). Type: Cape, *Burchell 4769* (K, lecto.!); a specimen labelled *Burchell 4969* (TCD!) may be an isotype; *Zeyher 954* (K!).

Idothea burchellii (Bak.) Kuntze, Rev. Gen. **2:** 712 (1891).

Drimia concolor Bak. in J. Linn. Soc., Bot. **11:** 422 (1871). Type: "Cap. B. Spei (e tab. ex exemplo in Hort. Kew. anno 1823 culto depicta descript)."

Idothea concolor (Bak.) Kuntze, Rev. Gen. **2:** 712 (1891).

Drimia rigidifolia Bak. in J. Linn. Soc., Bot. **11:** 420 (1871). Lectotype: "Somerset, *Bowker 225!*" (K!). *Syntype:* "Cap. B. Spei, *Harvey* ex hort. Baronis Ludwigii!" (not seen).

Idothea rigidifolia (Bak.) Kuntze, Rev. Gen. **2:** 712 (1891).

?Drimia rudatisii Schltr. in Engl. Bot. Jahrb. **40:** 89 (1907). Type: "Natal: an feuchten, schattigen Orten bei Fairfield (Alexandra County), c.750 m ü. M. (H. Rudatis n. 79)"; not located.

Bulb (30–)40–100(–120) mm long, usually more or less ovoid, reddish, sometimes with a sheath above up to 120 mm long, often densely colonial, hypogeal; scales loosely arranged or, more frequently, densely packed. *Leaves* almost always hysteranthous, (3–)8–15, linear or linear-lanceolate, (360–)400–440(–1 200) mm long, (18–)25–55(–70) mm broad, glabrous or villous on the surfaces, ciliate on the margins. *Peduncles* (220–)400–1 200(–1 800) mm long, with 30–100(–200) flowers in an elongate (often rather dense) raceme. *Bracts* (1–)4–13(–32) mm long; the lowest with a spur (3–)5–15(–23) mm long. *Pedicels* (3–)5–10(–20) mm long. *Perianth* very variable in colour (transparent green, mauve, white striped with brown, silvery white, pink, purple) but most frequently pinkish with or without a darker or greenish-brown dorsal stripe, (9–)12–16(–23) mm long, fused for 3–6(–7) mm; segments reflexed in the daylight. *Filaments* (6–)7–11 mm long, sublinear, tapering from the base, purple or white or white above and purple below; anthers dorsifixed, 1–2 mm long, dark purple or dark blue-grey. *Ovary* ovoid, 2,5–4 mm long, green; style 8–13 mm long, capitate, minutely 3-lobed. *Capsule* ellipsoid, 13–16 mm long. *Seeds* winged, angled, 6–7 × 2–3 mm.

D. elata is widespread in South Africa, except for the dry regions.

It has been recorded from a wide range of habitats, but most frequently from open grassveld, especially near water. Less often it occurs actually in swamps or among rocks. Flowers are produced in summer.

As recognised in this work, *D. elata* includes a wide range of forms, but the short perianth tube, the reflexed segments, hysteranthous sublinear leaves and red bulb are characteristic. Species treated here as synonymous with *D. elata*, but given separate status by previous authors, have been identified by having shorter pedicels (*D. burchellii*) or often by differences in the leaf indumentum. However, as leaves are usually absent, there must remain a large amount of unidentifiable herbarium material. It has, moreover, been found that there is no correlation between the distribution of hairs and inflorescence or floral characters. Both glabrous and villous leaves occur over most of the geographical range of the species.

A few specimens, which may belong here, differ sufficiently to cause difficulty in identification. *Dyer 3143* (PRE) from Pretoria and *Van der Merwe 2478* (PRE) from Rooiberg (Thabazimbi) differ, for example, in having pale-coloured scaly bulbs, but otherwise closely resemble *D. elata*. *Barker 10194* (NBG) from 3 miles N. of Vanrhynsdorp is exceptionally small, with most measurements just below the minima in the description given here.

For illustrations see Kidd, M.M. (1950), *Wild flowers of the Cape Peninsula*, pl. 23, fig. 5 and Flower. Pl. S. Afr. **23:** t.890 (1943).

Selected Specimens

BOTSWANA—2425 (Gaberones): Kanye, *Hillary & Robertson 609* (PRE).
TRANSVAAL—2229 (Waterpoort): 8 miles N of Louis Trichardt, *Van Vuuren 1264* (PRE).
—2329 (Pietersburg): Louis Trichardt, *Breyer s.n.* sub Tvl Mus. *24378* (PRE).
—2330 (Tzaneen): Magoebas Kloof, *Compton 18096* (NBG).
—2427 (Thabazimbi): Rooiberg, *Van der Merwe 2803* (PRE).
—2430 (Pilgrim's Rest): Mariepskop, *Killick & Strey 2404* (PRE).
—2527 (Rustenburg): Hennops River, *Leendertz s.n.* sub Tvl Mus. *8172* (PRE).
—2528 (Pretoria): Baviaanspoort, *Dyer 3143* (PRE).
—2529 (Witbank): Loskopdam, *Theron 1898* (PRE).
—2530 (Lydenburg): Upper Moodies, *Galpin 629* (PRE).
—2531 (Komatipoort): confluence of Komati and Crocodile Rivers, *Bolus 7626* (BOL).
—2626 (Klerksdorp): Rietfontein, *Louw 1183* (PRE).
—2627 (Potchefstroom): Goedgedacht, Ventersdorp, *Sutton 632* (PRE).
—2628 (Johannesburg): Melville Koppies, *Macnae 1487* (NBG).
—2629 (Bethal): 2 miles S.E. of Standerton, *Godfrey H-1422* (PRE).
—2630 (Carolina): Carolina, *Roberts s.n.* sub Tvl Mus. *15284* (PRE).
SWAZILAND—2531 (Komatipoort): Havelock Concession, *Saltmarshe s.n.* sub *Galpin 1056* (PRE, SAM).
—2631 (Mbabane): Forbes Reef, *Compton 22405* (NBG).
ORANGE FREE STATE—2727 (Kroonstad): Kroonstad, *Pont 591* (PRE).
—2826 (Brandfort): Glen, *Mostert 713* (PRE).
—2925 (Jagersfontein): Rotorua, Fauresmith, *Henrici 2628* (PRE).
—2926 (Bloemfontein): Thaba 'Nchu, *Roberts 2936* (PRE).

NATAL—2730 (Vryheid): Hlobane, *Johnstone 451* (NU).
—2731 (Louwsburg): Nongoma Townlands, *Gerstner 4610* (PRE).
—2829 (Harrismith): Winterton, *Dohse 74* (PRE).
—2830 (Dundee): 3 miles E. of Nqutu, *Codd 7665* (PRE).
—2831 (Nkandla): Ngoye Forest, *Ross 2124* (PRE).
—2832 (Mtubatuba): Hluhluwe Game Reserve, *Fakude 53* (NU, PRE).
—2929 (Underberg): Estcourt, *West 1355* (PRE).
—2930 (Pietermaritzburg): Table Mountain, *Killick 199* (NU).
—2931 (Stanger): Groutville, *Moll 2515* (NU, PRE).
—3029 (Kokstad): Bedford, Harding, *Lennox s.n.* (NU).
—3030 (Port Shepstone): near Dumisa, *Strey 4306* (PRE).
CAPE—3029 (Kokstad): near Clydesdale, *Tyson 2168* (BOL, GRA, PRE).
—3118 (Vanrhynsdorp): 4 miles E. of Van Rhyn's Dorp, *Hall 3594* (NBG).
—3124 (Hanover): Hanover, *Marloth 5682* (PRE).
—3125 (Steynsburg): 12 miles S.W. of Middelburg, *Acocks 16594* (PRE).
—3126 (Queenstown): Andriesberg, near Bailey, *Galpin 2230* (PRE).
—3217 (Vredenburg): Saldanha Bay, *Hall s.n.* sub NBG *72487* (NBG).
—3218 (Clanwilliam): Clanwilliam, *Leipoldt 418* (SAM).
—3225 (Somerset East): Bruintjeshoogte, *MacOwan 1854* (GRA).
—3227 (Stutterheim): Pirie, *Flanagan 2239* (BOL, PRE, SAM).
—3228 (Butterworth): near Qolora Mouth, *Pegler 1440* (BOL).
—3317 (Saldanha): Hoedjies Bay, *Hall s.n.* sub NBG *72460* (NBG).
—3318 (Cape Town): Signal Hill, *Marloth 7001* (PRE).
—3319 (Worcester): Tulbagh, *Esterhuysen 17491* (BOL).
—3320 (Montagu): near Touws River, *Zinn s.n.* sub SAM *65806* (SAM).
—3322 (Oudtshoorn): Cango Valley, *Marloth 12127* (PRE).
—3323 (Willowmore): N. of Joubertina, *Fourcade s.n.* (Fourcade collection, BOL).
—3325 (Port Elizabeth): Parsons Vlei, *Long 137* (GRA).
—3326 (Grahamstown): Grahamstown, *Glass 567* (SAM).
—3327 (Peddie): East London, *Smith 3764* (PRE).
—3418 (Simonstown): Witsands, *Penfold 260* (NBG).
—3419 (Caledon): Riviersonderend, *Zeyher 4259* (SAM).
—3423 (Knysna): Knysna Heads, *Fourcade 2024* (Fourcade collection, BOL).
—3424 (Humansdorp): Kabeljauws, *Fourcade 3355* (Fourcade collection, BOL).

12. **Drimia cooperi** (Bak.) Bak. in Fl. Cap. **6:** 443 (1897).

Ornithogalum cooperi Bak. in J. Linn. Soc., Bot. **13:** 284 (1873). Type: Cape, "ad oram orientalis", *Barber s.n.* (TCD, lecto.!, K!).

Bulb 25–50 mm long, narrowly ovoid to globose; the scales more or less firmly arranged, pale, with fine threads where the leaf blades have been shed or where damaged. *Leaves* synanthous, 2–4, sublinear, 80–270 mm long, 8–13 mm broad, glabrous, firm. *Peduncles* 400–600 mm long, with 35–70 flowers in a rather elongate raceme. *Bracts* 2–7 mm long; the lowest with a spur 2–3 mm long. *Pedicels* 2–4 mm long, erect-spreading. *Perianth* greenish-white, rather conspicuously striped on keel in dried material, fused for 1–1,5 mm; segments 5–6 mm long, oblong, probably spreading. *Filaments*, 1,5–3 mm long, narrowly lanceolate, tapering from the base, attached to the perianth segments above the tube; anthers dorsifixed, *c.* 1. mm long. *Ovary* ovoid, 2–3 mm long, with 15–20 ovules per locule; style *c.* 3 mm long, subcapitate. *Fruits* unknown.

Recorded from a rather limited region of the Cape Province in the Stutterheim and Butterworth degree blocks.

Occurs on grassy hills and flowers in early summer.

Florally this species is similar to *D. anomala*, but in other respects appears to be rather isolated.

SELECTED SPECIMENS

CAPE—3227 (Stutterheim): near Komgha, *Flanagan 1302* (BOL, PRE, SAM); near Kei Road Station, *Galpin 8243* (PRE).
—3228 (Butterworth): Kentani, *Pegler 1395* (BM, BOL).

13. **Drimia altissima** (L.f.) Ker-Gawl. in Curtis's bot. Mag. **27:** t. 1074 (1808).

Ornithogalum altissimum L.f., Suppl. 199 (1781). Type: "Cap. bonae spei," *Thunberg s.n.* (UPS–*8275*, microfiche!). There is also a Thunberg specimen in S!.

Urginea altissima (L.f.) Bak. in J. Linn. Soc., Bot. **13:** 221 (1873).

Idothea altissima (L.f.) Kuntze, Rev. Gen. **2:** 712 (1891).

Ornithogalum giganteum Jacq., Hort. Schoenbr. **1:** 45, t. 87 (1797). Type: Jacq., Hort. Schoenbr. **1:** t. 87 (1797).

Drimia uitenhagensis Eckl. in S. Afr. Quart. Jl. **1:** 364 (1830). Type: "On the hills of Adow, (District Uitenhage)," not located, but the 3–4 ft long inflorescence and hysteranthy makes its identification virtually certain. *Ecklon 17* (S!), without locality, may be type material and would confirm this identification.

Urginea kniphofioides Bak. in Fl. Cap. **6:** 469 (1897). Type: Transvaal, Havelock Concession, *Saltmarshe s.n.* sub *Galpin 1055* (K, holo.!, BOL!).

Urginea forsteri Bak. in Fl. Cap. **6:** 469 (1897). Syntypes: Cape, near Hopefield, *Bachmann 1708* (Z!); Worcester Division, *Cooper 3275* (K!); without locality, *Forster s.n.* (K!); *Wallich s.n.* (BM!, K!).

Urginea epigea R. A. Dyer in Flower. Pl. Afr. **26:** t. 1027 (1947). Type: Transvaal, Middelburg District, N. of Zoetvelden, *Van der Merwe 2203* (PRE, holo.!).

Bulb 90–200 mm long, epigeal and with only fleshy rather loose scales, or hypogeal and with outer membranous scales and more tightly packed inner fleshy scales; scales whitish to pale green. *Leaves* almost always hysteranthous, (3–) 5–10(–16), oblong to narrowly oblong-lanceolate, 200–400(–450) mm long, 25–40(–65) mm broad. *Peduncles* (600–)700–1 500(–2 500) mm long, usually with 100–300 flowers which may be arranged in whorl-like clusters but are usually spirally arranged. *Bracts* 5–7 mm long; the lowest with a spur rarely exceeding 2 mm long, and usually caducous. *Pedicels* (2–)5–20(–25) mm long, erect-spreading. *Perianth* white or cream-coloured with or without a green dorsal stripe, fused to 2 mm or subfree, spreading or less often reflexed; segments (3–) 7–10(–15) mm long. *Filaments* 3,5–9(–12) mm long, linear to narrowly linear-lanceolate; anthers dorsifixed, 1–3 mm long. *Ovary* ellipsoid to ovoid, 2–4 mm long; style 2,5–5(–11) mm long; stigma undifferentiated or distinctly capitate. *Capsule* obovoid, cordate at the base, 10–12 mm long. *Seeds* flat, elliptic, *c*.5–9 × *c*.4–5 mm.

Very widespread in southern Africa but apparently largely absent from the Kalahari and much of the Orange Free State.

D. altissima occurs on loose sandy soils and in firmer clay or gravel soils. There is a similar tolerance to climatic conditions, but it occurs more frequently in areas with a rainfall below about 500 mm per annum. Flowers are produced in most months of the year, but most records are for summer. There does not appear to be any correlation between geographical distribution and flowering season—

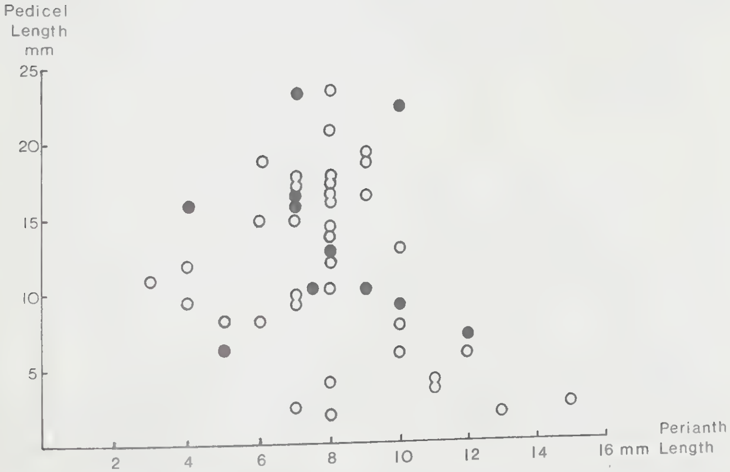

FIG. 2.

Diagram to illustrate variation in pedicel and perianth lengths in *Drimia altissima*. Solid dots indicate plants known to have epigeal bulbs. Based on herbarium specimens.

winter and summer flowering having been recorded for both summer and winter rainfall areas.

Of the names reduced here to synonymy, two require particular attention. In 1947 Dyer wrote of *Urginea epigea* that it differed from *U. altissima* in having a less dense inflorescence and in its epigeal bulb. He overlooked a possible additional character in that the pedicels are generally longer—over 15 mm—in the material he was describing from the Transvaal (although this character is related to the density he observed). In floral and leaf characters there appears to have been no supplementary justification for the separation of these species. Figure 2 illustrates the correlation between pedicel length and perianth length with, where known, an indication of whether the bulb is epigeal or hypogeal. However, as pointed out by Dyer, there are many herbarium specimens in which the bulb character cannot be determined. Geographically, epigeal bulbs are characteristic of the eastern and northern Transvaal, but also occur in populations in South West Africa, Natal and the eastern Cape. Hypogeal bulbs occur virtually throughout the range of the species—that is from the south-western Cape, through the eastern Cape, Natal, most of the Transvaal (including the east and north), South West Africa and the territories to the north.

In the absence of any correlation between bulb form and other morphological characters, or the geographical isolation of the bulb forms, it is not considered justified to separate two taxa on this single character. However, plants grown in cultivation in the nursery of the Botanical Research Institute for up to six years, have retained distinct bulb characters. It is considered improbable that bulbs occur above ground in extensive populations of several hundred or more individuals only as a result of erosion of the soil or other edaphic conditions. Genetic differences are likely to exist.

For illustration, see Flower. Pl. Afr. **26:** t.1027 (1947).

Selected Specimens

SOUTH WEST AFRICA—1716 (Enana): 18,8 miles N. of Ondongua on road to Omafo, *De Winter 3620* (PRE).

—1719 (Runtu): 16,2 miles S. of Runtu, *De Winter 3786* (PRE).

—1724 (Katima Mulilo): Caprivi Strip, E. of Cuando River, *Curson 1072* (PRE).

—1917 (Tsumeb): 13,4 miles S. of Tsumeb on road to Grootfontein, *De Winter 3685* (PRE).

—2219 (Sandfontein): Sandfontein, *Wilman s.n.* sub BOL *15279* (BOL).

—2319 (Aminuis): 60 miles S.E. of Gobabis, *Basson 93* (PRE).

BOTSWANA—2022: 5 miles S. of Mwaku Pan, *Van der Spuy 31* (PRE).

TRANSVAAL—2231 (Pafuri): 27 miles N.E. of Punda Maria, *Codd & Dyer 4621* (PRE).

—2329 (Pietersburg): 3 miles E. of Boyne, *Van Vuuren 1269* (PRE).

—2330 (Tzaneen): Hans Merensky Nature Reserve, *Oates 104* (PRE).

—2428 (Nylstroom): Warmbaths, *Leendertz s.n.* sub Tvl Mus. *6577* (PRE).
—2429 (Zebediela): Percy Fyfe Nature Reserve, *Huntley 1907* (PRE).
—2431 (Acornhoek): 18 miles from Satara on Rabelais road, *Van der Schijff 3292* (PRE).
—2526 (Zeerust): Bierkraal, 50 miles N. of Rustenburg, *Steyn s.n.* sub O.P. *15708* (PRE).
—2528 (Pretoria): Premier Mine, *Pole Evans 9823* (PRE).
—2529 (Witbank): Middelburg, *Van der Merwe 2203* (PRE).
—2530 (Lydenburg): Sabie, *Rogers 18812* (BOL).
—2531 (Komatipoort): 16 miles W. of Skukuza, *Codd 5696* (PRE).

SWAZILAND—2531 (Komatipoort): Havelock Concession, *Saltmarshe s.n.* sub *Galpin 1055* (BOL).
—2731 (Louwsburg): 10 miles W. of Gollel, *Ben Dlamini s.n.* (PRE).

ORANGE FREE STATE—2925 (Jagersfontein): Fauresmith Veld Reserve, *Henrici 3573* (PRE).

NATAL—2632 (Bella Vista): Ndumu Hill, *Pooley 3* (NU).
—2730 (Vryheid): Naauwhoek, *Devenish 1178* (PRE).
—2731 (Louwsburg): near Rooikranz, *Dyer 5040* (PRE).
—2732 (Ubombo): Mkuzi Game Reserve, *Ward 4455* (PRE).
—2831 (Nkandla): Hluhluwe Game Reserve, *Ward 3730* (PRE).
—3030 (Port Shepstone): Ixopo, *Webb s.n.* (PRE).

CAPE—3118 (Vanrhynsdorp): 5 miles N. of Vanrhynsdorp, *Pearson & Pillans s.n.* sub P.S.M. Expedition 1910/11 no. *5457* (BOL).
—3125 (Steynsburg): Zuurberg, *MacOwan 2195* (GRA).
—3126 (Queenstown): between Queenstown and Dordrecht, *Werdemann & Oberdieck 1077* (PRE).
—3218 (Clanwilliam): Piquetberg, *Marloth 7692* (PRE).
—3224 (Graaff-Reinet): near Graaff-Reinet, *Bolus 649* (BOL).
—3225 (Somerset East): Boschberg, *MacOwan s.n.* (GRA, Z).
—3226 (Fort Beaufort): Bedford, *Theron 582* (PRE).
—3227 (Stutterheim): near Komgha, *Flanagan 1188* (BOL, SAM).
—3228 (Butterworth): Butterworth, *Pegler 1155* (BOL).
—3317 (Saldanha): Saldanha Bay, *Leighton 2363* (BOL).
—3318 (Cape Town): Lions Head, *Wolley Dod 2277* (BOL).
—3319 (Worcester): near De Doorns, *Bolus 13032* (BOL, GRA, PRE).
—3325 (Port Elizabeth): Uitenhage, *Dahlstrand 350* (GRA).
—3326 (Grahamstown): Alicedale, *Cruden s.n.* (GRA).
—3418 (Simonstown): Llandudno, *Leighton 458* (BOL, PRE).
—3419 (Caledon): near Caledon on Shaws Pass road, *Lewis 3260* (SAM).
—3421 (Riversdale): Korente River to Heidelberg road, *Thompson 707* (PRE).
—3422 (Mossel Bay): Mossel Bay, *Marloth 7329* (PRE).

14. **Drimia macrocentra** (Bak.) Jessop, comb. nov.

Urginea macrocentra Bak. in Gdnrs' Chron. 1887, **1:** 702 (1887). Type: Cape, Transkei, *Barber 895* (K, holo.!).

Urginea lilacina Bak. in Fl. Cap. **6:** 469 (1897). Types: Natal, Inanda, *Wood 198* (K!, NH!—syn.); *Wood 642* (K, lecto.!; BM!, NH!—syn.).

Urginea echinostachys Bak. in Fl. Cap. **6:** 468 (1897). Type: Natal, Inanda, *Wood 276* (K, holo.!).

Urginea schlechteri Bak. in Bull. Herb. Boissier, sér. 2, **4:** 1000 (1904). Type: Natal, Claremont, *Schlechter 3155* (ex errore *3158*) (BOL!, GRA!, K!, PRE!, Z!).

Bulb 30–50 mm long, ovoid to globose; scales firmly arranged. *Leaf* usually hysteranthous, solitary, cylindrical, 400–1 000 mm long, *c.* 15 mm broad in dried material. *Peduncles* 250–800(–900) mm long, with 50–100 flowers in a more or less elongate raceme. *Bracts* 4–5 mm long, brown or pink to orange; lowermost 2 or 3 with a spur 25–35 mm long and up to 7 mm broad distally, early caducous. *Pedicels* (2–)7–10(–12) mm long, erect-spreading. *Perianth* white or pink, with or without a green keel, fused for less than 1 mm, 6–7(–8) mm long; segments spreading. *Filaments* 4–5 mm long, linear-lanceolate; anthers dorsifixed, 0,75–1 mm long. *Ovary* ovoid, *c.*3 mm long, with 10–15 ovules per locule; style 1,5–3 mm long, minutely 3-lobed. *Capsule* ovoid to ellipsoid, 9–11 mm long. *Seeds* more or less flat, asymmetrical, *c.*5 mm long.

Occurs throughout Natal and in the extreme east of the eastern Cape.

Grows in a wide range of habitats, including both forest and open mountain slopes and in wet places. Flowers are produced in early summer—especially October and November.

The affinity of this species is probably with *D. sanguinea.* The larger size, single cylindrical leaf and very large spur to the lowest bracts are diagnostic, and this species is very clearly demarcated from any other.

For illustration see Flower. Pl. S. Afr. **4:** t.142 (1924).

SELECTED SPECIMENS

NATAL—2828 (Bethlehem): Mont aux Sources, *Schweickerdt 635* (PRE).
—2829 (Harrismith): Cathedral Peak Forest Station, *Killick & Marais 2140* (K, NU, PRE).
—2830 (Dundee): Krantzkop, *Thode s.n.* sub STE *3480* (STE).
—2831 (Nkandla): Empangeni, *Mackay s.n.* sub *Marloth 11659* (PRE).
—2929 (Underberg): Giants Castle, *Tinley s.n.* (NU).
—2930 (Pietermaritzburg): Nottingham Road, *Galpin 9579* (PRE).
—3030 (Port Shepstone): Dumisa, *Rudatis 438* (L, PRE, S, Z).
CAPE—3029 (Kokstad): Mt Currie, *Goossens 357* (PRE, Z).
—3127 (Lady Frere): Tsomo River, *Bowker s.n.* sub SAM *23224* (SAM).

15. **Drimia sanguinea** (Schinz) Jessop, comb. nov.

Urginea sanguinea Schinz in Verh. Bot. Ver. Prov. Brandenburg **31:** 219 (1890). Type: "Osnambonde in Nord-Hereroland", *Schinz 25* (Z, holo.!, K!).

Urginea burkei Bak. in Fl. Cap. **6:** 469 (1897). Types: Transvaal, near Vaal River, *Nelson 170* (K!, PRE!-syn.); Magaliesberg, *Burke s.n.* (K, lecto.!, BM! -syn.); Mozambique, between Lourenço Marques and Puzeens, *Bolus 7628* (BOL!, K!-syn.).

Urginea rautanenii Bak. in Bull. Herb. Boissier, sér. 2, **3:** 664 (1903). Type: "Deutsch-Südwest-Afrika, Amboland, Ondonga", *Rautanen s.n.* (Z, holo.!).

Bulb (40–)55–90 mm long, usually ovoid, often with a distinct neck up to 100 mm long and a woody basal portion up to 25 mm long; scales tightly packed, red. *Leaves* usually hysteranthous, 3–8, linear-lanceolate, 250–300(–350) mm long, (3–)4–10(–14) mm broad. *Peduncles* (60–)200–450(–600) mm long, with (40–) 50–70(–80) flowers. *Bracts* 1–2 mm long; lowest with spurs *c.*1 mm long, but early caducous. *Pedicels* (2–)4–12(–14) mm long, erect-spreading. *Perianth* white with or without a brown dorsal stripe, more or less free, 8–11 mm long, spreading or slightly reflexed. *Filaments* 5–7 mm long, linear to linear-lanceolate; anthers dorsifixed, 1–2,5 mm long. *Ovary* ovoid or oblong-ovoid, 3,5–4 mm long; style 3–4 mm long, distinctly capitate. *Capsule* ellipsoid or ovoid-ellipsoid to oblong, (10–)12–18(–20) mm long. *Seeds* flat, elliptic to oblong, 7–12 × 4–6 mm.

Widespread in South West Africa, the Cape north of the Orange River and the Transvaal.

Occurs most frequently on the Kalahari sands, but also recorded from hard pan soil. Flowers are produced in spring and early summer.

D. sanguinea has been fairly well collected, perhaps because it is an important cause of stock poisoning. It appears to be particularly clearly demarcated and constant in its characters. However, in the Transvaal the capsule tends to be smaller (under 15 mm) than in the plants from South West Africa (over 17 mm). This character is not, however, considered to be sufficiently well-defined or sufficiently well correlated with any other characters to be used in separating distinct taxa.

For illustration see Flower. Pl. S. Afr. **4:** t.138.

Selected Specimens

SOUTH WEST AFRICA—1815 (Okahakana): 38 miles S. of Ondonua on road to Okaukuejo, *De Winter 3619* (PRE).
—1917 (Tsumeb): Tsumeb, *Naegelsbach 17* (PRE).
—1918 (Grootfontein): 40 miles E. of Grootfontein, *Van Vuuren 1185* (PRE).
—2219 (Sandfontein): Sandfontein, *Wilman s.n.* sub BOL *15237* (BOL).
—2317 (Rehoboth): Rehoboth, *Volk 705* (PRE).

BOTSWANA—1925: Ngamiland, Nata to Tamasetsi, *Pole Evans 4633* (PRE).
—2022: 16 miles from Tsau to Shakawe, west of Okavongo Swamps, *Story 4733* (PRE).
—2425 (Gaberones): between Molepolole and Matlogagang, *Van Rensburg B4140* (PRE).
TRANSVAAL—2329 (Pietersburg): Dendron, *Van der Merwe 1962* (PRE).
—2428 (Nylstroom): 15 miles N.W. of Nylstroom, *Codd 6152* (PRE).
—2526 (Zeerust): Marico, *Van der Merwe 20* (PRE).
—2527 (Rustenburg): Rustenburg, *Leendertz s.n.* sub Tvl Mus. *9670* (PRE).
—2528 (Pretoria): Zwartkop, *Repton 1815* (PRE).
—2626 (Klerksdorp): Rooijantjiesfontein, between Lichtenburg and Gerdau, *Kinges 1894* (PRE).
—2627 (Potchefstroom): Potchefstroom, *Goossens 1672* (PRE).
—2628 (Johannesburg): Vaal River, *Nelson 170* (PRE).
—2725 (Bloemhof): Wolmaransstad, *Sutton 63* (PRE).
CAPE—2624 (Vryburg): Mosito, Manbogossa, *Daly s.n.* sub SAM *23232* (SAM).
—2723 (Kuruman): 3 miles N.E. of Kuruman, *Leistner 972* (PRE).
—2822 (Glen Lyon): Bergenaars Pad, *Acocks & Hafström H1375* (PRE).
—2823 (Griekwastad): 10–30 miles E. of Postmasburg, *Acocks & Hafström H1121* (PRE).
—2824 (Kimberley): Warrenton, *Adams 209* (GRA).
—2922 (Prieska): Asbestos Hills near Griquatown, *Marloth 7686* (PRE).

16. **Drimia delagoensis** (Bak.) Jessop, comb. nov.

Urginea delagoensis Bak. in Fl. Cap. **6:** 467 (1897). Type: Mozambique, between Delagoa Bay and the Lebombo Mountains, *Bolus 7627* (K, holo.!, BOL!).

Urginea lydenburgensis R. A. Dyer in Flower. Pl. S. Afr. **22:** 859 (1942). Type: Transvaal, Lydenburg District, *Swart s.n.* sub PRE *23303* (PRE, holo.!).

Urginea ubomboënsis R. A. Dyer in Flower. Pl. S. Afr. **22:** t.859 (1942), ex errore *U. delagoensis* Bak.

Bulb (25–)40–50(–150) mm long, usually in small groups, ovoid, often with a rather gnarled exterior, sometimes above ground and then with looser scales, often with a pronounced membranous sheath round base of leaves; scales red in dried material, internally often light brown with or without a green surface to the outside of the bulb. *Leaves* synanthous, 3–8, cylindrical or channelled on the ventral surface, 130–300(–450) mm long, 2–10(–15) mm broad. *Peduncles* 200–300(–600) mm long, with (10–)20–50(–60) flowers arranged in a more or less elongate raceme. *Bracts* 2–5 mm long; lowest bracts with a spur *c.*2 mm long, but early caducous or aborting. *Pedicels* 1,5–5(–6) mm long, erect-spreading. *Perianth* light brown, creamy white or pale mauve, with or without a darker area or stripe on the dorsal surface, 3–5(–5,5) mm long; segments spreading. *Filaments* 2,5–4 mm long, linear; anthers dorsifixed, 1 mm long. *Style* 1,5–2 mm long, minutely 3-lobed. *Capsule* narrowly ellipsoid, 7–10 mm long. *Seeds* narrowly lanceolate, 4–8 × 1–2 mm.

Occurs in the lowveld of the Transvaal, Swaziland and Zululand, and also recorded from Mozambique.

Its most frequent locality appears to be among rocks, but also reported from boggy ground and in forest. Flowers are produced mainly from August to October, but also in other months from mid-winter to mid-summer.

This species is closely allied to *D. sanguinea*, with which it shares the property of being toxic.

For illustration see Flower. Pl. S. Afr. **22:** t.858 (1942).

SELECTED SPECIMENS

TRANSVAAL—2530 (Lydenburg): Lydenburg, *Swart s.n.* sub O.P. *12268* (PRE); Nelspruit, *Buitendag 118* (PRE).
—2531 (Komatipoort): N. bank of Sabie near Skukuza, *Codd 5717* (PRE); Hlahlabse Hill near Malelane, *Codd 6088* (PRE).
SWAZILAND—2731 (Louwsburg): Ngwavuma, *Bayliss 3458* (PRE); 7 miles W. of Gollel, *Compton 29108* (NBG, PRE).
NATAL—2632 (Bella Vista): Mahumane, *Pooley 642* (NU).
—2732 (Ubombo): Pongola Poort, *Repton 5986* (PRE); Jozini Dam, *Strey 5149* (PRE).
—2831 (Nkandla): Hluhluwe, *Ward 1415* (PRE); Umhluhluwe Springs, *Gerstner 3108* (BOL, PRE).

17. **Drimia marginata** (Thunb.) Jessop, comb. nov.

Anthericum marginatum Thunb., Prodr. **63** (1794). Type: Cape, ‘‘ex Hantam’’, *Thunberg s.n.* (UPS-*8393*, holo., microfiche!).

Idothea marginata (Thunb.) Kunth, Enum. Pl. **4:** 346 (1843).

Urginea marginata (Thunb.) Bak. in J. Linn. Soc., Bot. **13:** 218 (1873).

Anthericum pusillum Jacq., Icones **2** (16): 18, t.417 (1795). Type: Jacq., Icones **2** (16): t.417 (1795).

Caesia pusilla (Jacq.) Spreng., Syst. **2:** 88 (1825).

Idothea drimioides Kunth, Enum. Pl. **4:** 345 (1843), nom. nov. for *Anthericum pusillum* Jacq.

Urginea pusilla (Jacq.) Bak. in J. Linn. Soc., Bot. **13:** 217 (1873).

Bulb 30–35 mm long, ovoid to globose, sometimes producing a short neck, hypogeal; scales white, sometimes rather loosely packed. *Leaves* hysteranthous, 2–3, linear to spathulate, acute to emarginate, spreading to erect, tough and leathery, glabrous, dark green and shiny, sometimes with a brownish cartilaginous margin, 40–100(–150) mm long, 9–25 mm broad. *Peduncles* 120–260 mm long, with 10–15(–40) flowers arranged in a head. *Bracts* 1–2 mm long; the lowest with a spur up to *c*.1 mm long. *Pedicels* *c*.7–9 mm long, spreading to ascending. *Perianth* brown, 5–6 mm long, with a tube *c*.1 mm long; segments oblong to narrowly ovate, reflexing. *Filaments* *c*.3 mm long, lanceolate, attached at top of perianth tube; anthers dorsifixed, *c*.1 mm long. *Ovary* ovoid to ellipsoid, 2–3 mm long; style 1–1,5 mm long, subcapitate. *Fruit* unknown.

Restricted to the south-western Cape.

Habitat not recorded by collectors, but it appears to grow both in the Karoo and in the mountain macchia. Flowers are produced in summer.

D. marginata is very similar to *D. capitata* on inflorescence and floral characters but differs on leaf characters. The more or less spreading leaves with characteristic leathery hard texture and margins are diagnostic and, with its geographical distribution, enable identification to be made very readily. However, specimens are known which do not appear to conform to these concepts. *Muir 4126* (PRE) from ''flats around Riversdale'' has leaves apparently similar (oblanceolate to obovate) but up to only about 17 mm long. There are two inflorescences attributed to this plant, both from Marloth's garden. One (flowered in 1926) is capitate, but the other (flowered in 1927) has long internodes and longer pedicels. The second specimen (without collector or number; PRE) from the Long Kloof has identical leaves to those of *Muir 4126*, but the flowers are larger (perianth segments 5 mm long as opposed to 3–3,5 mm in *Muir 4126*), and the anthers (not seen in *Muir 4126*) appear basifixed. Further east (e.g. *Cruden 355;* GRA) to Port Elizabeth similar plants have leaves often with ciliate margins and produce lax inflorescences. The data at present available is not sufficient to decide on the status of these specimens.

Selected Specimens

CAPE—3017 (Hondeklipbaai): 1 mile N. of Kamieskroon, *Hardy & Bayliss 1109* (PRE).
—3018 (Kamiesberg): between Garies and Bitterfontein, *Mathews s.n.* sub NBG *2167/29* (BOL).
—3118 (Vanrhynsdorp): Klaver, *Compton s.n.* sub NBG *320/22* (BOL).
—3119 (Calvinia): Akkerdam, Hantam Mountain slopes, *Barker 9343* (NBG).
—3218 (Clanwilliam): Zebra Kop, Piketberg, *Esterhuysen 14487* (BOL).
—3219 (Wuppertal): near Elandsfontein, *Schlechter 10038* (GRA, Z).
—3319 (Worcester): Hansiesberg, *Compton 16689* (NBG).
—3320 (Montagu): Visgat, Ceres, *Esterhuysen 13500* (BOL).

18. **Drimia depressa** (Bak.) Jessop, comb. nov.

Urginea depressa Bak. in Bull. Herb. Boissier, sér. 2, **4:** 1000 (1904). Type: Transvaal, Modderfontein, *Conrath 687* (Z, lecto.!, K!).

Ornithogalum capitatum Hook. in Curtis's bot. Mag. **88:** t.5388 (1863). Type: "British Kaffraria", *Cooper 208* (K, holo.!); non *Drimia capitata* Bak., 1897.

Urginea capitata (Hook.) Bak. in Fl. Cap. **6:** 465 (1897).

Bulb (10–)25–40(–50) mm long, often colonial, ovoid to ovoid-elliptic; scales tightly packed, white. *Leaves* usually hysteranthous, 5–8, linear to linear-lanceolate, (80–)100–240(–260) mm long, (4–)10–26 mm broad. *Peduncles* (25–)50–100(–200) mm long, sometimes paired, but usually solitary, with 10–20(–50) flowers in a globose head. *Bracts* 0,5–4 mm long; the lowest with spurs 1–6 mm long. *Pedicels* (3–)8–12(–15) mm long, more or less spreading. *Perianth* white with purple, brown or pink dorsal surface or dorsal stripe, fused for less than 1 mm, 3–6 mm long; segments linear-oblong, spreading. *Filaments* 3–4 mm long, lanceolate, white; anthers dorsifixed, 0,5–1,25 mm long, brown. *Ovary* ovoid, 2–3 mm long, white, with *c*.15 ovules per locule; style 1,5–2,5 mm long. *Capsule* ovoid, 5–8 mm long. *Seeds* flat, usually asymmetrical, 4–4,5 × 3–4 mm.

Widespread in the Transvaal (especially to the south), Natal, Swaziland, Lesotho and the eastern Cape.

Occurs in open grassveld or among stones. Flowers are produced in late winter, spring and occasionally in summer and open in the evening.

Urginea capitata and *U. depressa* have been separated in the past because of the latter's supposedly having narrower leaves and shorter peduncles and perianth segments. *U. capitata* was the name applied to material from the Cape and through Natal to Barberton, while *U. depressa* was applied to material from the rest of the Transvaal. However, an examination of all the available specimens has satisfied the present author that there is no justification for recognising two species in this complex.

There are three species of capitate drimias, recognised in the present work. *D. sphaerocephala*, with a distinct perianth tube and reflexed often more brightly coloured segments, is readily distinguishable. *D. marginata* and *D. depressa* are separated on less distinct characters. In addition, there are specimens identified in various herbaria as belonging to *Urginea ecklonii* Bak. The type of this species has not been located (*Ecklon & Zeyher* Asphod. *128*), and with the limited material available it has not been decided where these specimens should be placed. The following specimens (all SAM) have been, for example, identified as *U. ecklonii*: *Lewis 1442* from the foot of the Schurfteberg, Ceres Division; *Stokoe s.n.* sub SAM *68059* from Cedarberg Duivelskop. The inflorescence of these plants is capitate (peduncle 90–200 mm long), pedicels 10–20, 4–11 mm long and the perianth 4–5 mm long; which agrees closely with *D. depressa* as defined here. The only leaves appear etiolated and possibly developed during pressing and in the dark and are very narrow, *c.*1 mm diameter. If the mature leaves are found to be narrow it would exclude the possibility of these plants belonging to *D. marginata* or even, possibly, *D. depressa.* In that event it is possible that these plants may have to be placed in a new species (or possibly in *U. ecklonii*). Baker's material on which he based *U. ecklonii* lacked leaves.

It is not always easy to distinguish *D. depressa* from *D. physodes,* although generally the latter is a species of drier areas—Karoo, Kalahari and the Orange Free State, and has pedicels over 15 mm long and a distinctly elongate inflorescence. Nevertheless, these two species are undoubtedly very closely related. *Louw 1049* (PRE) from Witkop, Potchefstroom, appears closer to *D. physodes* but has pedicels about 10 mm long. *Repton 1340* (PRE) from Lyttleton (Verwoerdburg) is more distinctly like *D. physodes* in the form of the inflorescence, but with pedicels just over 10 mm long. Other specimens similar to *Repton 1340* are known from the Nylstroom area.

For illustration see Batten, A. & Bokelmann, H. (1966), *Wild flowers of the eastern Cape Province,* pl. 12, fig. 3.

SELECTED SPECIMENS

TRANSVAAL—2527 (Rustenburg): Heuningklipkloof, Krugersdorp, *Repton 4154* (PRE).
—2528 (Pretoria): Murraysfield, *Strey 2979* (PRE).
—2529 (Witbank): Bronkhorstspruit, 27½ miles S.W. of Groblersdal, *Acocks 23344* (PRE).
—2531 (Komatipoort): Saddleback Mountain, *Galpin 987* (GRA, K, PRE, SAM).
—2626 (Klerksdorp): Mondeor, Ventersdorp, *Mogg s.n.* sub *J26619* (PRE).
—2627 (Potchefstroom): Krugersdorp, *Acocks 18728* (PRE).
—2628 (Johannesburg): Brakpan, *Murray 406* (PRE).
—2629 (Bethal): Nooitgedacht, *Potter 1713* (PRE).
—2630 (Carolina): Carolina, *Rademacker s.n.* sub Tvl Mus. *7483* (PRE).
SWAZILAND—2631 (Mbabane): Ukutula, Mbabane, *Compton 27998* (NBG).
NATAL—2730 (Vryheid): Naauwhoek, *Devenish 734* (K, PRE).
—2828 (Bethlehem): Mont aux Sources, *Trauseld 274* (NU, PRE).
—2829 (Harrismith): Cathedral Peak, *Esterhuysen 12918* (BOL).
—2830 (Dundee): Kaffir Drift, *Thode A368* (PRE).
—2929 (Underberg): near Lowlands, *Acocks 10547* (PRE).
—2930 (Pietermaritzburg): Oribi Aerodrome, *Moll 1877* (NU, PRE).
—3030 (Port Shepstone): Dumisa, *Rudatis 1438* (G, K, P, Z).
LESOTHO—2828 (Bethlehem): Leribe, *Dieterlen 363* (P, PRE).
—2927 (Maseru): Mamathes, *Jacot Guillarmod 1820* (PRE).
CAPE—2824 (Kimberley): Kimberley, *Wilman s.n.* (BOL).
—3029 (Kokstad): Kokstad, *Tyson 1842* (BOL, GRA, K, PRE, SAM).

—3129 (Port St Johns): West Gate, Port St Johns, *Galpin.*
—3225; (Somerset East): Bruintjieshoogte, without collector sub SAM *23188* (SAM).
—3227 (Stutterheim): near Komgha, *Flanagan 1723* (BOL, PRE, SAM).
—3324 (Steytlerville): between Kareedouw and Assegaai, *Jeppe s.n.* sub *Fourcade 4992* (Fourcade collection, BOL).

19. **Drimia multisetosa** (Bak.) Jessop, comb. nov.

Urginea multisetosa Bak. in Fl. Cap. **6:** 468 (1897). Lectotype: Natal, near Mooi River, *Wood 5724* (K!). Syntypes: Transvaal, Upper Moodies, *Galpin 584* (PRE!, K!).

Bulb 25–70(–80) mm long, ovoid to ovoid-oblong, with long fibres (often about 20–30 mm long) distally; scales white or creamy to yellow coloured, sometimes with a pinkish tinge, more or less densely packed. *Leaves* usually hysteranthous, but appearing before flowering completed, few, linear, 120–400 mm long, flat and 7–14 mm broad, or 200–300 mm long, subterete, channelled above, fleshier and 1–2 mm broad. *Peduncles* (200–)300–500(–800) mm long, with 20–30(–50) flowers in an elongate raceme. *Bracts* 1,5–3 mm long; lowest with persistent spur 1–3 mm long. *Pedicels* (2–)5–13 mm long, erect to erect-spreading. *Perianth* brown, yellowish or white, with a brown to black (sometimes green) dorsal stripe, with a tube 1–1,75 mm long, 4,5–6 mm long, spreading to reflexed. *Filaments* (1,5–)3–4 mm long, lanceolate, white; anthers dorsifixed, 1–1,5 mm long. *Ovary* ovoid to globose, 2,5–3 mm long; style 2–2,5 mm long; stigma scarcely differentiated to very strongly capitate. *Capsule* subglobose, ellipsoid or obovoid, 6–10 mm long. *Seeds* ellipsoid to arcuate, 4–7 mm long.

Occurs widely in Natal, the Orange Free State and the Transvaal, with a single record for the eastern Cape.

Grows in a wide range of habitats, including open grassveld, sand, shale or among rocks, or in the shade of savanna trees. Flowers in late spring to early summer. There may be two forms worthy of taxonomic recognition on the basis of leaf characters mentioned in the description above. But because of the hysteranthous behaviour of the leaves there is insufficient material to determine the extent of these forms.

Goossens 1677 (PRE) from Potchefstroom is of interest as its anthers are exceptionally long—approximately the same length as the filaments, whereas in most material they are about half the length.

For illustration see Flower. Pl. S. Afr. **22:** t.854 (1942).

SELECTED SPECIMENS

TRANSVAAL—2330 (Tzaneen): Duivelskloof, *Scheepers 686* (PRE, Z).
—2528 (Pretoria): Irene, *Obermeyer 69* (PRE).
—2530 (Lydenburg): Badplaas, *Van der Merwe 1637* (PRE).

—2627 (Potchefstroom): Potchefstroom University grounds, *Goossens 1677* (PRE).
—2628 (Johannesburg): Modderfontein, *Conrath 686* (Z).
ORANGE FREE STATE—2727 (Kroonstad): Kroonstad, *Pont 482* (PRE, Z).
NATAL—2730 (Vryheid): Tweekloof, Utrecht, *Thode A301* (PRE).
—2929 (Underberg): Giants Castle Game Reserve, *Trauseld 999* (NU, PRE).
—2930 (Pietermaritzburg): Scottsville, *Allsopp 885* (NU).
CAPE—3029 (Kokstad): Mvenyani, Cedarville, *Bandert 21* (GRA).

20. **Drimia physodes** (Jacq.) Jessop, comb. nov.

Anthericum physodes Jacq., Icones **2** (16): 18, t.418 (1795). Type: Jacq., Icones **2** (16): t.418 (1795).

Albuca physodes (Jacq.) Ker-Gawl. in Curtis's bot. Mag. **26:** t.1046 (1807).
Caesia physodes (Jacq.) Spreng., Syst. **2:** 88 (1825).
Idothea physodes (Jacq.) Kunth, Enum. Pl. **4:** 345 (1843).
Urginea physodes (Jacq.) Bak. in J. Linn. Soc., Bot. **13:** 217 (1873).

Bulb 40–75(–100) mm long, ovoid to ovoid-globose, sometimes with a distinct neck of several dry scales; scales whitish or pale yellow inside, with a few pergamentaceous outer scales. *Leaves* hysteranthous, 5–8, linear-lanceolate to lanceolate, erect, twisted, acute to subobtuse, 70–150(–200) mm long, 15–25(–37) mm broad, tending to glaucous greyish green. *Peduncles* (70–)100–200(–250) mm long, usually with 50–100 flowers arranged in a corymb or subcapitate at first but elongating later, purple-brown, occasionally pubescent. *Bracts* *c*.0,5 mm long; lowest with a spur less than 1 mm long. *Pedicels* 15–20 mm long, usually more or less spreading but sometimes reflexing in fruit, *c*.0,1 mm diameter but becoming at least twice as thick in fruit. *Perianth* white with brown or purplish on the dorsal surface, with a strongly marked, sometimes pubescent vein, fused for 0,5–1 mm, 4–6,5 mm long, linear-oblong, spreading. *Filaments* 2–3 mm long, lanceolate; anthers dorsifixed, *c*.1 mm long. *Ovary* ovoid, 2–3,5 mm long, with *c*.12–16 ovules per locule; style 1,5–2 mm long; stigma minutely 3-lobed. *Capsule* ellipsoid, 3-lobed, 7–10 mm long. *Seeds* flat, sometimes asymmetrical, 5–10 × up to 7 mm.

Widespread in the Cape Province except the extreme eastern parts, and present in the Orange Free State.

Particularly abundant on surface limestone deposits, but occurs generally over its range in both karroid and macchia vegetation. Flowers are produced in most months, but especially summer, and open in the late afternoon.

Selected Specimens

ORANGE FREE STATE—2825 (Boshoff): road between Windsorton Road and Boshoff, *Leistner 1534* (K).

—2925 (Jagersfontein): Fauresmith, *Smith 5256* (PRE).
CAPE—2721 (Tellery Pan): Massaklous Pan, 20 miles S.S.E. of Kuruman River, *Leistner 3135* (PRE).
—2722 (Olifantshoek): Postmasburg, 50 miles N.W. of Olifantshoek, *Leistner 2071* (K, PRE).
—2816 (Oranjemund): Swartwater, near Orange River, *Hall 617* (NBG).
—2823 (Griekwastad): Griquatown, *Marloth 6097* (PRE).
—2824 (Kimberley): Witpan, Kimberley, *Topp s.n.* sub *Marloth 13418* (PRE).
—2917 (Springbok): Steinkopf, *Meyer s.n.* sub *Marloth 6396* (PRE).
—2922 (Prieska): near Omdraai, *Bryant 1166* (PRE).
—2923 (Douglas): Douglas, *Marloth 9434* (PRE).
—3018 (Kamiesberg): Marble Mine, Moedverloer, Hol River, *Hall 3478* (NBG).
—3024 (De Aar): near De Aar, *Ridley s.n.* sub SAM *4410* (SAM).
—3118 (Vanrhynsdorp): Strandfontein, Vredendal, *Hall 3493* (NBG).
—3119 (Calvinia): Nieuwoudtville, *Bolus s.n.* (BOL).
—3125 (Steynsburg): Zuurberg, *Tyson 1858* (BOL).
—3218 (Clanwilliam): Clanwilliam, *Leipoldt 417* (K, SAM).
—3219 (Wuppertal): Welbedacht, Cedarberg, *Esterhuysen 20068* (BOL).
—3220 (Sutherland): Sutherland, *Krige s.n.* sub *Fuller 261* (BOL).
—3318 (Cape Town): Banhoek Peak, *Esterhuysen 19915* (BOL).
—3319 (Worcester): Seven Sisters, *Esterhuysen 18320* (BOL).
—3320 (Montagu): Tweedside, *Marloth 12099* (PRE).
—3322 (Oudtshoorn): Robinson Pass, Mossel Bay, *Esterhuysen 19413* (BOL).
—3323 (Willowmore): Joubertina, *Esterhuysen 21242* (BOL).
—3324 (Steytlerville): Kouga, Uniondale, *Esterhuysen 4673* (BOL).
—3418 (Simonstown): Kogel Bay, *Leighton 2490* (BOL).

21. **Drimia anomala** (Bak.) Bak. in Fl. Cap. **6:** 442 (1897).

Ornithogalum anomalum Bak. in Saund., Ref. Bot. **3:** t.178 (1870). Type: "sent from South Africa by Cooper", Saund., Ref. Bot. **3:** t.178 (1870). A specimen from Saunders' garden (K!) was not communicated to Kew until 1882 and is, therefore, not treated as the type although it may have come from the type material.

Urginea eriospermoides Bak. in Gdnrs' Chron. 1887, **2:** 126 (1887). Type: Cape, *MacOwan s.n.* (K, holo.!).

Bulb (25–)35–80 mm long, globose, usually with a sheath 25–30(–100) mm long; scales tightly packed, white. *Leaves* synanthous, usually solitary, cylindrical, glossy dark green, withering from the apex, but transverse plates associated with abscission laid down, 170–300 mm long, 3,5–4 mm broad. *Peduncles* 280–500(–600) mm long, with 14–80 flowers arranged in an elongate raceme. *Bracts* c.1 mm long, lowest with a spur 1–2 mm long. *Pedicels* (2–)3–5(–8) mm long, up to 12 mm long in fruit, erect-spreading. *Perianth* white, pale pink, beige, yellow or greenish, usually with a darker green, brown or reddish dorsal stripe, fused for *c*.1 mm, 4–5 mm long, spreading to recurved. *Filaments* 2,5–3 mm long, erect-spreading but never connivent; anthers dorsifixed, *c*.1 mm long. *Ovary* ovoid to ellipsoid, 1,5–2 mm long; style 1,5–2 mm long, minutely capitate or stigma not differentiated. *Capsule* ellipsoid, 4–6 mm long. *Seeds* strongly angled, 1,5–2 mm long.

Widespread in the eastern half of the Cape Province, with a single record from Natal.

Occurs in grassveld, among rocks, and in semi-desert areas. The flowers are produced throughout summer and are scented.

Marloth 8314 (PRE) from Jansenville is of interest as it has longer pedicels (*c*.10 mm) and a red bulb.

For illustration see Flower. Pl. Afr. **28:** t.1117 (1951).

SELECTED SPECIMENS

NATAL—3030 (Port Shepstone): Gibralter, *Strey 10020* (PRE).
CAPE—3029 (Kokstad): near Kokstad, *Tyson 1867* (NBG).
—3123 (Victoria West): near Murraysburg, *Tyson 165* (BOL, NBG).
—3125 (Steynsburg): Bangor Farm, *Bolus 14107* (BOL).
—3126 (Queenstown): near Fincham's Neck, *Galpin 2202* (BOL).
—3224 (Graaff-Reinet): Oudeberg near Graaff-Reinet, *Bolus 270* (BOL).
—3225 (Somerset East): near Somerset East, *MacOwan 1853* (GRA, Z).
—3226 (Fort Beaufort): Fort Armstrong, Balfour, *Martin 147* (NBG).
—3227 (Stutterheim): King Williams Town, *Sim 1721* (PRE).
—3228 (Butterworth): Butterworth, *Pegler 1801* (PRE).
—3322 (Oudtshoorn): Moeras River, *Barker 7732* (NBG).
—3323 (Willowmore): Die Hoek, near Joubertina, *Esterhuysen 18343* (BOL, PRE).
—3324 (Steytlerville): near Steytlerville, *Compton 20314* (NBG).
—3325 (Port Elizabeth): Red House, *Paterson 2648* (GRA).
—3326 (Grahamstown): Trappes Valley, *Bayliss 3082* (PRE).
—3327 (Peddie): Chalumna Causeway, *Barker 6965* (NBG).
—3423 (Knysna): Plettenberg Bay, *Esterhuysen 24210* (BOL).

22. **Drimia modesta** (Bak.) Jessop, comb. nov.

Urginea modesta Bak. in Engl. Bot. Jahrb. **15,** Beibl. 35: 6 (1892). Type: Pondoland, *Bachmann 273* (K, holo.!).

Urginea virens Schltr. in J. Bot., Lond. **1897:** 433 (1897). Syntypes: Cape, Tweefontein, *Schlechter 10127* (GRA!, BM!, K!, L!, P!, PRE!, Z!); Packhuisberg, *Leipoldt s.n.*

Urginea natalensis Bak. in Fl. Cap. **6:** 468 (1897). Types: Natal, Inanda, *Wood 277* (K, lecto.!, NH, syn.!); Umzinyati Falls, (NH, syn.!) *Wood 1036* (NH, syn.!).

Urginea riparia Bak. in Fl. Cap. **6:** 467 (1897). Type: Natal, Umzinyati Falls, *Wood 1052* (K, holo.!, NH!).

Urginea rubella Bak. in Fl. Cap. **6:** 467 (1897). Type: Natal, Mooi River, *Wood 5723* (K, holo.!, BM!, PRE!, BOL!).

Urginea dregei Bak. in Fl. Cap. **6:** 467 (1897). Syntypes: Cape, near Genadendal, *Bolus 7428* (BOL!); Du Toits Kloof, *Drège 1501* (K!).

Urginea tenella Bak. in Fl. Cap. **6:** 464 (1897). Type: Natal, Van Reenen, *Wood 4562* (K, holo.!, NH!).

Urginea pretoriensis Bak. in Bull. Herb. Boissier, sér. 2, **1:** 786 (1901). Type: Transvaal, Pretoria, Aapies River, *Rehmann 4307* (Z!).

Urginea pauciflora Bak. in Bull. Herb. Boissier, sér. 2, **1:** 786 (1901). Type: Natal, Umgeni Falls, *Rehmann 7455* (Z!); nom. illegit., non *U. pauciflora* Bak. (1892).

Urginea umgeniensis V. Poelln. in Ber. deutsch. bot. Ges. **61:** 209 (1944), nom. nov. for *U. pauciflora* Bak. (1901).

Urginea revoluta Duthie in Ann. Stell. Univ. **6A** (2): 9 (1928). Type: Stellenbosch Flats, *Duthie s.n.* sub STE *1874* (STE, holo.!, K!, PRE!), typical of western Cape members of *D. modesta* except that the perianth segments are strongly reflexed.

Urginea gracilis Duthie in Ann. Stell. Univ. **6A** (2): 10 (1928). Type: Stellenbosch Flats, *Duthie s.n.* sub STE *1446* (STE, holo.!, BOL!).

Urgineopsis salteri Compton in J. Bot., Lond. **68:** 107 (1930). Type: Cape Peninsula, Muizenberg on rock slabs, *Salter s.n.* sub BOL *18861* (BOL, lecto.!, BM!, K!).

Urginea salteri (Compton): Adamson in Jl S. Afr. Bot. **8:** 238 (1942).

Urginea arenosa Adamson in Jl S. Afr. Bot. **8:** 239 (1942). Type: Cape Peninsula, Red Hill, *Salter 8321* (BOL, holo.!, NBG!, K!).

Urginea pedunculata Adamson in Jl S. Afr. Bot. **10:** 134 (1944). Type: Cape Peninsula, Kalk Bay Mountains, *Levyns s.n.* sub *Adamson 3483* (BOL, holo.!).

Bulb 10–25 mm long, ovoid to globose, usually with whitish fleshy scales, less often reddish scales, and a few outer greyish to brown membranous scales, sometimes scales loosely arranged, but usually tightly packed, solitary to densely colonial, sometimes with a sheath up to or less often exceeding the length of the bulb and surrounding the base of the peduncle. *Leaves* usually hysteranthous, but especially in damp places occasionally synanthous, usually 4–8, linear, probably 100–150(–350) mm long, 1–2(–3) mm broad. *Peduncles* (25–)50–300(–400) mm long, with 2–40 flowers usually arranged spirally in a more or less elongate raceme, less often secund, straight or less often zigzagging. *Bracts* usually less than 1 mm long; lowest with a spur (2–)3–5(–7) mm long; most other bracts without spurs. *Pedicels* (2–)5–8 mm long, straight or arcuate, spreading to ascending, sometimes elongating in fruit and then up to 15 mm long. *Perianth* usually white with a brown, purple or mauve dorsal surface or dorsal stripe, free or subfree, (3–)4–5(–6) mm long, linear-oblong, spreading or less often ascending. *Filaments* 2–4 mm long, linear; anthers dorsifixed, yellow or brown, *c.*1 mm long. *Ovary* ovoid to ellipsoid or oblong, 1,5–3 mm long, green; style 1–1,5 mm long, minutely 3-lobed at the apex, white. *Capsule* rather narrowly ovoid-elliptic, 4–6 mm long. *Seeds* narrow, angled, 3–4 mm long.

Occurs throughout South Africa, except in the driest areas.

Occurs on rocky ledges in damp situations, on stream banks, marshy places and also in open grassveld and on stony hills. Flowers are produced in spring and summer, last only one day and are usually scented.

Plants from very damp areas differ considerably from plants from drier places. This has led to the recognition of species which cannot be upheld. Plants in wetter areas tend more often to form dense colonies, with darker coloured looser-scaled bulbs and larger synanthous leaves which tend to widen towards the base. This range in form resulting from growing in varying habitats is exactly parallelled in both summer and winter rainfall regions. In both of these areas there also seems to be a parallel series of forms with differing flower colours, numbers of flowers in the inflorescence and to some extent varying pedicel lengths.

The degree of fusion of the perianth has been employed not only in defining species but also in creating the new genus *Urgineopsis*. In the Transvaal most of the plants have virtually free segments, but in the south-western Cape, where in other respects the plants are very similar, there is a greater deal of variation in this respect. However, this variation has been found to be continuous and not to be associated with any other morphological or geographical characters and therefore not to warrant its use in recognising distinct taxa. Because of the small size of the flowers and the variation in a single inflorescence it is difficult to produce sufficiently meaningful measurements to demonstrate graphically the extent of this variation; Fig. 3 however indicates approximate perianth and tube lengths.

Young s.n. sub Tvl Mus. *32493* (PRE) is of interest as on this material there are rhizomes bearing bulbils. This appears to be an extremely rarely developed feature.

SELECTED SPECIMENS

TRANSVAAL—2330 (Tzaneen): Duivelskloof, Letaba, *Scheepers 1020* (PRE, Z).
—2428 (Nylstroom): Warmbaths, *Leendertz s.n.* sub Tvl Mus. *6529* (PRE).
—2429 (Zebediela): Potgietersrust, *Leendertz s.n.* sub Tvl Mus. *5652* (PRE).
—2527 (Rustenburg): Rustenburg, *Rogers 23425* (GRA, S).
—2528 (Pretoria): Donkerpoort, *Young 2425* (PRE).
—2530 (Lydenburg): Dullstroom, *Strey 3437* (PRE).

—2531 (Komatipoort): Sheba, near Barberton, *Bolus 7629* (BOL).
—2627 (Potchefstroom): Goedgedacht, Ventersdorp, *Sutton 600* (PRE).
—2628 (Johannesburg): Milner Park, Johannesburg, *Young 1214* (PRE).
—2729 (Volksrust): Volksrust, *Kamering s.n.* sub Tvl Mus. *5732* (PRE).
—2730 (Vryheid): Oshoek, Wakkerstroom, *Devenish 919* (PRE).
SWAZILAND—2631 (Mbabane): Millers Falls, *Compton 26190* (NBG).
—2632 (Bella Vista): Ngwenya Causeway, Stegi, *Karsten s.n.* sub NBG *71763* (NBG).
ORANGE FREE STATE—2828 (Bethlehem): Bethlehem, *Potgieter 4* (PRE).
—2829 (Harrismith): Swinburne, Rensburgskop, *Jacobsz s.n.* (PRE).
—2925 (Jagersfontein): Zamekomst, Fauresmith, *Henrici 1080* (PRE).
LESOTHO—2828 (Bethlehem): Leribe, *Dieterlen 404* (P, PRE).
—2927 (Maseru): Mamathes, *Jacot Guillarmod 1825* (PRE).
NATAL—2730 (Vryheid): Hlobane, *Johnstone 475* (NU).
—2731 (Louwsburg): Ngome, *Strey 9356* (PRE).
—2828 (Bethlehem): Mont aux Sources, *Schweickerdt 649* (PRE).

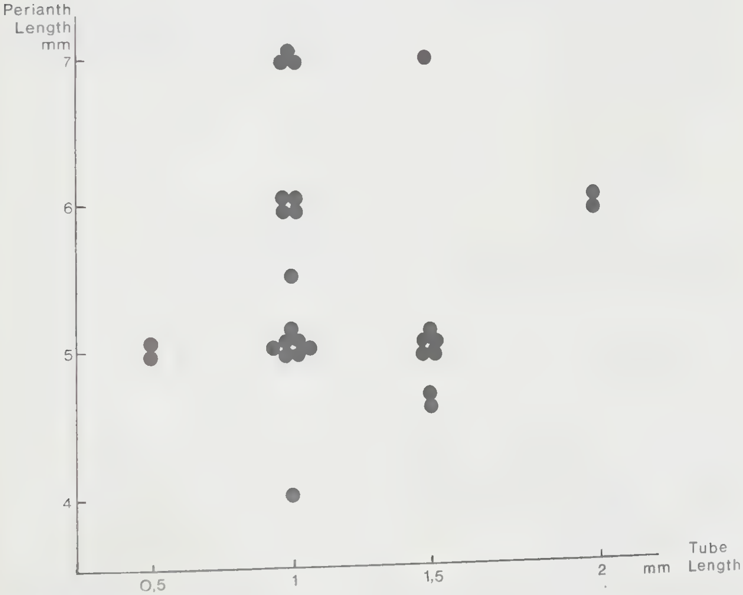

FIG. 3.

Diagram to illustrate variation in perianth length and in the length of fused portions of the perianth of *Drimia modesta* from the south-western Cape. Based on herbarium specimens.

—2829 (Harrismith): Bushmans River near Estcourt, *Schelpe 18* (NU).
—2830 (Dundee): Kaffir Drift, Utrecht, *Thode A369* (PRE).
—2929 (Underberg): Giants Castle Game Reserve, *Trauseld 408* (NU, PRE).
—2930 (Pietermaritzburg): Umbumbulu, *Wood 10174* (GRA, P, SAM).
—2931 (Stanger): Durban, *Ward 4683* (PRE).
—3030 (Port Shepstone): Fairfield, Alexandra, Dumisa, *Rudatis 755* (P, PRE).
CAPE—3027 (Lady Grey): Majuba Nek, *Hepburn 127* (GRA).
—3119 (Calvinia): Lokenburg, *Acocks 19740* (PRE).
—3125 (Steynsburg): Zuurberg, *Tyson 1858* (SAM).
—3126 (Queenstown): Andriesberg, *Galpin 2233* (BOL, GRA).
—3128 (Umtata): Tintwa, *Van der Merwe 2700* (NU, PRE).
—3129 (Port St Johns): Lusikisiki, Magwa Falls, *Strey 6717* (PRE).
—3219 (Wuppertal): Bokkeveld Tafelberg, *Schlechter 10105* (BOL, GRA, P, PRE).
—3226 (Fort Beaufort): top of Katberg, *Hutchinson 1648* (BOL).
—3227 (Stutterheim): Pirie, *Sim 1709* (PRE).
—3228 (Butterworth): near Kei Mouth, *Flanagan 206* (PRE).
—3318 (Cape Town): Kloof Corner, *Esterhuysen 22416* (BOL).
—3319 (Worcester): Michells Pass, *Schlechter 9962* (BOL, GRA, PRE, Z).
—3320 (Montagu): Strawberry Hill, Heidelberg, *Stokoe s.n.* sub SAM *68267* (SAM).
—3321 (Ladismith): Seven Weeks Poort, *Andreae 1342* (PRE).
—3325 (Port Elizabeth): Aloes, *Drège 3122* (PRE).
—3326 (Grahamstown): Alicedale, *Cruden 300* (PRE).
—3327 (Peddie): East London, *Rattray 621* (GRA).
—3418 (Simonstown): Orange Kloof, *Salter 9082* (NBG, SAM).
—3419 (Caledon): Onrust River, *Schlechter 10390* (BOL, GRA, Z).
—3420 (Bredasdorp): Grootvadersbos near Heidelberg, *Esterhuysen 18258* (BOL).
—3421 (Riversdale): 10 miles S. of Albertinia, *Acocks 22887* (PRE).

23. **Drimia minor** (Duthie) Jessop, comb. nov.

Urginea minor Duthie in Ann. Stell. Univ. **6A** (2): 11 (1928). Type: Stellenbosch Flats, *Duthie s.n.* sub STE *1546* (STE, holo.!, PRE!).

Urginea pygmaea Duthie in Ann. Stell. Univ. **6A** (2): 10 (1928). Type: Stellenbosch Flats, *Duthie s.n.* sub STE *1603* (STE, holo.!, K!, PRE!).

Urginea exilis Adamson in Jl S. Afr. Bot. **8:** 240 (1942). Type: Cape Peninsula, De Klip, *Salter 8312* (BOL, holo.!, NBG!, SAM!).

Bulb 10–15(–20) mm long, ovoid to globose; inner scales white; outer scales greyish and membranous, sometimes producing a neck. *Leaves* hysteranthous, 1–7, linear to terete, erect or spreading, (18–)25–40(–60) mm long, 0,3–1 mm broad, glabrous. *Peduncles* (18–)35–90 mm long, with (1–)2–4 flowers. *Bracts* less than 1 mm long; lowest with spurs less than 1 mm long. *Pedicels* 2–5(–6) mm long, straight, sometimes elongating slightly and/or becoming arcuate in fruit. *Perianth* brownish or white with a brown dorsal stripe, fused for 0,5–1 mm, 3–3,5(–5) mm long, spreading or somewhat recurved. *Filaments* 1,5–2 mm long, lanceolate; anthers dorsifixed, *c*.0,5 mm long. *Ovary* ovoid, *c*.1,5 mm long; style *c*.1 mm long, subcapitate. *Capsule* ovoid to ellipsoid, obtuse or acute at the apex, 4–6 mm long. *Seeds* angled or less often flattened, *c*.1,5 mm long.

Confined to the south-western Cape in the Cape Town, Stellenbosch and Caledon areas.

Recorded as growing on well-drained clay, sandy or gravelly soils. Flowers open in the morning, are produced in late summer.

For illustration see Kidd, M. M. (1950), *Wild flowers of the Cape Peninsula*, pl. 14, fig. 3.

SELECTED SPECIMENS

CAPE—3318 (Cape Town): Camp Ground, *Compton 17946* (NBG); W. side of Table Mountain, *Esterhuysen 14675* (BOL, PRE); Stellenbosch Flats, *Duthie s.n.* sub STE *1603* (K, PRE, STE).

—3418 (Simonstown): Schusters Kraal, *Penfold s.n.* sub NBG *73250* (NBG).

—3419 (Caledon): Schilpadkop area, Riviersonderend Mtns, *Esterhuysen 21040* (BOL).

Litanthus Harv.

J. Bot. Lond. **3:** 314, t.9 (1844).

Bulb imbricate with membranous outer scales. *Leaves* hysteranthous, basal, narrow-linear. *Peduncle* usually with 1 flower, solitary. *Bracts* 2 (one sterile), both spurred. *Flower* pendulous. *Perianth* fused to form a cylindrical tube for at least half its length, marcescent. *Capsule* loculicidal. *Seeds* usually angled, with loose-fitting testa.

Type species: Litanthus pusillus Harv.

Monotypic. *L. pusillus* occurs from the south-western Cape to Natal and the Transvaal.

The small number of pendulous flowers and the tubular perianth serve to separate *Litanthus* from *Drimia* to which it is, however, very closely related.

Harvey, in his type description, remarked "This is perhaps the smallest individual of the Liliaceous group". No species is known to the present author to have consistently smaller individuals, although *Drimia minor* may be of the same order of size.

Litanthus pusillus Harv. in J. Bot., Lond. **3:** 315, t.9 (1844). Type: "shady places in the woods by the Zwartkops River, Uitenhage, Cape of Good Hope", *Zeyher s.n.* (TCD, lecto.!, BOL!), *Drège 8514c*.

Bulb globose to ovoid, with whitish fleshy scales and few membranous outer scales, 6–13 mm long. *Leaves* usually hysteranthous, 1–3, narrowly linear, 15–70 mm long, erect or spreading. *Peduncles* usually solitary, erect, with 2 bracts and a single flower, (17–)20–80 mm long. *Bracts* spurred, *c*.1 mm long, including the spur. *Pedicels* 1–6 mm long, including the spur. *Pedicels* 1–6 mm long, recurved in flower, ascending in fruit. *Flowers* white or, rarely, pale pink. *Perianth segments* fused to form a cylindrical tube 2,5–5 mm long; free portion of segments ascending, *c*.1 mm long. *Filaments* very short, attached to upper part of the perianth tube; anthers dorsifixed, *c*.1 mm long, dehiscing longitudinally. *Ovary* sessile, more or less ellipsoid, *c*.1,5 mm long; style cylindrical, 2–3 mm long; stigma subcapitate. *Capsule c*.3–5 mm long. *Seeds* usually angled, *c*.0,5 mm long.

Although records are probably incomplete because of the small size of the plant, it appears to be very widespread in South Africa except for the dry interior.

Occurs most frequently in rock crevices in both damp and dry localities. Flowers in summer (September to March) and the flowers open in the late afternoon.

SELECTED SPECIMENS

TRANSVAAL—2527 (Rustenburg): Jack Scott Private Nature Reserve, *Wells 2485* (PRE).
—2530 (Lydenburg): Waterval Boven, *Van der Merwe s.n.* sub PRE *3206* (PRE).
—2628 (Johannesburg): Johannesburg, *Bredenkamp 454* (PRE).

SWAZILAND—2531 (Komatipoort): Havelock Concession, *Saltmarshe s.n.* sub *Galpin 1042* (BOL & PRE).

ORANGE FREE STATE—2827 (Senekal): Groot Doornkop, Senekal, *Goossens 932* (PRE).
—2927 (Maseru): 18 miles from Hobhouse on Ladybrand road, *Acocks 11186* (PRE).

LESOTHO—2828 (Bethlehem): Leribe, *Dieterlen 855* (P, PRE).
—2927 (Maseru): Mamathes, *Jacot Guillarmod 882* (PRE).

NATAL—3030 (Port Shepstone): Gibralter, *Strey 10019* (PRE).

CAPE—3118 (Vanrhynsdorp): Papendorp, *Hall 3291* (NBG).
—3224 (Graaff Reinet): Cave Mountain, near Graaff Reinet, *Bolus 241* (BOL).
—3226 (Fort Beaufort): Oxton Manor, Whittlesea, *Galpin 8386* (PRE).
—3323 (Willowmore): Uniondale, *Esterhuysen 16868a* (BOL).
—3325 (Port Elizabeth): Red House, *Paterson s.n.* sub GRA *2083* (PRE).

Schizobasis Bak. J. Bot., Lond. **11:** 105 (1873).

Bulb imbricate. *Leaf* usually 1, narrowly linear; lamina present only on young bulbs, otherwise represented by bulb scales only. *Peduncles* erect or twining, usually much-branched, photosynthetic. *Bract* one to each flower, spurred. *Pedicel* one in the axil of each bract, not articulated. *Perianth segments* spreading, shortly fused, similar, marcescent. *Filaments* narrowly lanceolate, not connate, basally adnate to the perianth; anthers dorsifixed. *Ovary* sessile, subellipsoid to ovoid; style simple; stigma not differentiated or slightly 3-lobed. *Capsule* loculicidal. *Seeds* flat or angled.

Type species: S. macowanii Bak. (= *S. intricata* (Bak.) Bak.)

Distributed throughout most of South Africa and South West Africa.

KEY TO THE SPECIES OF *SCHIZOBASIS* IN SOUTHERN AFRICA.

Plants erect .... 1. **intricata**
Plants twining .... 2. **cuscutoides**

1. **Schizobasis intricata** (Bak.) Bak. in J. Bot., Lond. **1874:** 140 (1874).

Anthericum intricatum Bak. in J. Bot., Lond. **1872:** 140 (1872). Syntypes: banks of the Orange River, *Burke s.n.;* without locality, *Zeyher 4284* (SAM!).

Anthericum flagelliforme Bak. in J. Bot., Lond. **1872:** 140 (1872). Type: "Aapages river" (Aapies River, Transvaal), *Burke s.n.*

Schizobasis flagelliformis (Bak.) Bak. in J. Linn. Soc., Bot. **15:** 261 (1876).

Schizobasis macowanii Bak. in J. Bot., Lond. **1873:** 105 (1873). Type: "Inter frutices prope Somerset East", *MacOwan 1847* (BOL!, SAM!).

Schizobasis schlechteri Bak. in Bull. Herb. Boissier, sér. 2, **1:** 783 (1901). Type: "Südwest-Afrika (Natal): Regio orientalis prope Umtata, alt. 3400 pedes" (sic!), *Schlechter 6327* (BOL!, PRE!, Z!). This specimen was collected at Umtata, Transkei.

Schizobasis dinteri Krause in Engl. Bot. Jahrb. **48:** 355 (1912). Type: "Gross-Namaland: bei Marienthal in der Kuswüste unterhalb des Staudammes", *Dinter 2005* (SAM!).

Asparagus micranthus Thunb., nom. nud. (specimens labelled by Thunberg in UPS).

Bulb globose, with pale (white, pink or yellowish) fleshy scales, often with a few membranous, less often fibrous. *Leaves* absent, except in seedling stage, linear, *c*.40–60 mm long. *Peduncles* 1–3 per bulb, rather wiry, erect, usually *c*.100–500 mm high, sometimes zigzagging at the nodes, glabrous or pubescent towards the base, usually purplish towards the base and green above, usually much branched; branches reflexing from the base and curving up, or ascending from the base and straight—when the plant may adopt a virgate habit. *Bracts* spurred at all nodes, rarely exceeding 2–3 mm in length including the strongly reflexed spurs. *Pedicels* varying from all similar in length (usually increasing in length slightly from the apex) and up to *c.*7 mm long, to varying from *c.*10–*c.*50 mm in length on the same branch and strongly arcuate. *Perianth segments* very shortly fused, spreading, whitish or pale yellow to pale pink, with or without a greenish or brown longitudinal dorsal stripe, usually 3–4 mm long. *Filaments* attached near the base of the perianth segments, narrowly lanceolate, slightly shorter than the perianth segments; anthers dorsifixed, less than 1 mm long. *Ovary* sessile, subellipsoid to ovoid, *c.*1,5 mm long, with *c.*4–8 ovules per locule; style cylindrical, *c.*1–1,5 mm long; stigma undifferentiated or slightly 3-lobed. *Capsule* more or less ellipsoid, *c.*3,5–5 mm long. *Seeds* flat or angled, *c.*2 mm long.

Recorded from most of South Africa, Swaziland, southern Botswana and southern South West Africa. Specimens, not seen by the present author, have been reported from as far north in South West Africa as the Otjiwarongo district (Sölch, Roessler & Merxmüller, 1970).

Occurs in grassveld or among rocks. Flowers in summer. The flowers are not scented.

There is a considerable range in the form of branching of the aerial axes. In many specimens, especially from the central districts of South Africa, there is a strong zigzagging of the axes at the nodes which, with widely spreading branches, produces the appearance of dichotomous branching. Other plants, from widespread localities but especially in the southern Transvaal, southern Cape and parts of South West Africa, possess a virgate branching form. The former is strongly reminiscent of the habit of some forms of *Asparagus subulatus* or *A. exuvialis,* while the latter is reminiscent of *A. virgatus.* Associated with the virgate form there is a tendency for the pedicels to be more similar to one another in length than is the case in the more divaricately branched form. Because of the rather isolated (geographically) records of the virgate form and the gradients in form linking it with the other form, no taxonomic status has been allocated to it.

SELECTED SPECIMENS

SOUTH WEST AFRICA—2517 (Gibeon): *Dinter 2005* (SAM).
—2718 (Grünau): Great Karasberg, *Pearson s.n.* sub Percy Sladen Memorial Expedition 1912/13 no. *8303* (BOL).
BOTSWANA—2425 (Gaberones): N.W. of Molepolole, *Codd 8932* (PRE).
TRANSVAAL—2229 (Waterpoort): Wylliespoort, Soutpansberg, *Codd 4869* (PRE).
—2329 (Pietersburg): Haenertsburg, *Hafström & Acocks 226* (PRE).
—2330 (Tzaneen): Modjadji's Reserve, near Duivelskloof, *Krige 200* (PRE).
—2527 (Rustenburg): Magaliesberg, Rustenburg, *Pegler 1072* (BOL).
—2528 (Pretoria): Aapies River, Magaliesberg, *Schlechter 3624* (BOL, GRA, PRE, SAM, Z).

—2531 (Komatipoort): 12 miles N.E. of Barberton on road to Kaapmuiden, *Codd 1632* (PRE).
—2627 (Potchefstroom): Isaac Stegmann Nature Reserve, *Mogg 34682* (PRE).
—2628 (Johannesburg): Zoo Kopjes, *Moss 19052* (PRE).

SWAZILAND—2631 (Mbabane): Sibowe River, Hlatikulu, *Ben Dlamini s.n.* sub PRE *32060* (PRE).

ORANGE FREE STATE—2925 (Jagersfontein): S.E. slopes of Vaalberg, *Smith 5482* (PRE).
—2926 (Bloemfontein): Bestersput, *Acocks 8498* (PRE).
—3025 (Colesberg): 12 miles beyond Trompsburg on road to Philippolis, near Blaauheuwel, *Werger 220* (PRE).

NATAL—2731 (Louwsburg): Louwsburg, above Pivaans River, Rooikrans, *Dyer 5042* (PRE).
—2831 (Nkandla): near Old Gold Mine, *Venter 3000* (PRE).

CAPE—2823 (Griekwastad): Campbell, *Acocks s.n.* (BOL).
—2824 (Kimberley): Barkly West, *Acocks 1514* (PRE).
—2917 (Springbok): 23 miles S.W. of Steinkopf, *Marloth 13258* (PRE).
—2922 (Prieska): near Prieska, *Fuller 113* (BOL).
—3126 (Aliwal North): Elands Hoek, near Aliwal North, *Bolus 234* (BOL).
—3119 (Calvinia): 1,75 miles N. of Calvinia, on slopes of Hantamsberg, *Smith 2480a* (PRE).
—3126 (Queenstown): Bowker's Kop, *Galpin 2208* (GRA, PRE).
—3128 (Umtata): Umtata, *Schlechter 6327* (BOL, GRA, PRE).
—3225 (Somerset East): Little Fish River, near Somerset East, *MacOwan 1847* (BOL, SAM).
—3226 (Fort Beaufort): Woburn, *Acocks 11155* (PRE).
—3227 (Stutterheim): King Williams Town, *Sim 1051* (SAM).
—3319 (Worcester): Klaasvoogds, *Esterhuysen 22711* (BOL).
—3320 (Montagu): Bonnievale, *Marloth 11997* (PRE).
—3322 (Oudtshoorn): Prince Albert, *Marloth 2291* (PRE).
—3325 (Port Elizabeth): Zuurberg, *Holland 213* (GRA).
—3326 (Grahamstown): Howison's Poort, *Bolus 9136* (BOL, PRE).

2. **Schizobasis cuscutoides** (Burch. ex Bak.) Benth. & Hook.f., Gen. Pl. **3:** 786 (1883).

Asparagus cuscutoides Burch. ex Bak. in J. Linn. Soc., Bot. **14:** 606 (1875). Type: "Caput Bonae Spei, in saxosis aridis ad ripas fluminis Gariep", *Burchell 2673* (L!, P!).

Schizobasis buchubergensis Dint. in Feddes Rep. **30:** 80 (1932). Type: S.W.A., Buchuberge, *Dinter 6493*.

Bulb globose to ovoid, with pale-coloured fleshy scales and usually with a few membranous outer scales, usually 20–50 mm long. *Leaves* absent from mature plants, not recorded for the juvenile stage. *Peduncles* 1–3 per bulb, rather wiry, twining, usually 100–150 mm long, tortuous but not zigzagging at the nodes; branches more or less spreading. *Bracts* spurred at all nodes, rarely exceeding 2–3 mm in length including the strongly reflexed spur. *Pedicels* usually 5–10 mm long. *Perianth segments* very shortly fused, spreading, whitish, with or without a brown or green longitudinal stripe, usually 3–4 mm long. *Filaments* attached near the base of the perianth segments, narrowly lanceolate, slightly shorter than the segments; anthers dorsifixed, less than 1 mm long. *Ovary* sessile, subellipsoid to ovoid, *c*.1,5 mm long, with *c*.4–8 seeds per locule; style cylindrical, *c*.1–1,5 mm long; stigma undifferentiated or slightly 3-lobed. *Capsule* more or less ellipsoid, *c*.3,5–5 mm long. *Seeds* flat or angled, *c*.2 mm long.

Recorded from a rather narrow belt from southern South West Africa (Buchuberge in the Lüderitz district) and the northern Cape to Swaziland.

Occurs in grassveld and in semi-desert especially in rocky places. Flowers are produced in summer and no scent has been recorded.

The isolated and distant localities in which this species has been found are puzzling, and the overall similarities between this species and *S. intricata* create some difficulty in justifying its separation. The difference lies entirely in whether the plant is erect or climbing. It is considered possible that this may result from differences in environmental conditions, but in the absence of further data it is preferred to recognise two species.

SELECTED SPECIMENS

SWAZILAND—2631 (Mbabane): Komati Bridge, Pigg's Peak, *Compton 30691* (NBG, PRE).

ORANGE FREE STATE—2824 (Kimberley): between Kimberley and Jacobsdal, *Schweickerdt 1142* (PRE).

—2926 (Bloemfontein): Bloemfontein, *Potts 472* (BOL).

CAPE—2820 (Kakamas): Aughrabies Falls, *Acocks 16382* (PRE).

—2822 (Glen Lyon): Langebergen at Bergenaarspad, *Acocks 2098* (PRE).

—2917 (Springbok): near Spitskop, Steinkopf, *Meyer s.n.* sub *Marloth 13688* (PRE).

Bowiea Harv. ex Hook.f.

Curtis's bot. Mag. **93:** t.5619 (1867), nomen conservandum, non *Bowiea* Haworth, Lond. Edinb. Dubl. Philos. Mag. **64:** 299 (1824).

Schizobasopsis Macbride in Contrib. Gray Herb. n.s. **56:** 3 (1918).

Type species: S. volubilis (Harv. ex Hook.f.) Macbride.

Bulb usually partly epigeal, with imbricate scales. *Leaves* linear, lamina present only in seedling stage, otherwise represented by bulb scales only. *Peduncles* twining, succulent, much-branched, photosynthetic; many of the branches sterile. *Bract* one to each flower, spurred. *Pedicel* one to each bract, not articulated. *Perianth segments* spreading or reflexed, free or very shortly fused, similar, persistent, not marcescent. *Filaments* sublinear, expanding towards the base, attached at the base of the perianth; anthers dorsifixed, dehiscing longitudinally. *Ovary* sessile, ovoid to conical; style subcylindrical; stigma minutely 3-lobed. *Capsule* loculicidal. *Seeds* angular with loosely fitting testa.

Type species: Bowiea volubilis Harv. ex Hook.f.

Two species have been described; one from tropical Africa. The other is widespread in South Africa.

Bowiea volubilis Harv. ex Hook.f. in Curtis's bot. Mag. **93:** t.5619 (1867). Syntypes: Katberg, *Hutton s.n.* (TCD!); "eastern frontier", *Barber 892* (TCD!); *Barber 952* (TCD!); sine loc., *Cooper s.n.* (*Cooper 3609,* O.F.S. and *Cooper 3263,* Natal, both Z! and both identified by Harvey).

Schizobasopsis volubilis (Harv. ex Hook.f.) Macbride in Contrib. Gray Herb. n.s. **56:** 3 (1918).

Bulb subglobose or depressed globose, with whitish scales except the aerial parts of the semi-epigeal bulb which are green, usually without membranous outer scales, (15–)40–150 mm diameter. *Peduncles* 1–3, fleshy, green, much-branched, climbing to 0,5–2(–6) m. *Bracts* spurred, rarely over 4 mm long including the spur. *Pedicels* solitary, spreading or ascending, up to 100 mm long. *Flowers* white, green or yellowish green. *Perianth segments* fleshy, spreading or reflexed, more or less free, narrowly lanceolate, 5–9 mm long. *Filaments* sub-linear above, expanding towards the base, 3–6 mm long, attached at the base of the perianth; anthers 0,75–1 mm long. *Ovary* ovoid to conical, 2–3 mm long; style 2,5–4 mm long. *Capsule* ovoid, 8–12(–14) mm long. *Seeds* angular.

Occurs in southern South West Africa, the northern and eastern Cape, the Transvaal, Natal and north at least as far as Rhodesia.

Although most frequently found among bushes and trees, especially along river banks, it also occurs in drier areas, usually among boulders, or even in the open. Flowers are produced principally in summer and are not scented.

Despite the wide range of the species, there is not a very great degree of variation. Plants from the dry western localities do, however, tend to be very much more succulent.

For illustration see Flower. Pl. S. Afr. **21:** t.815 (1941).

SELECTED SPECIMENS

SOUTH WEST AFRICA—2819 (Ariamsvlei): Velloordrift, *Dinter 5195* (BOL, G, PRE, S, Z).
TRANSVAAL—2428 (Nylstroom): Pyramid Estate, near Potgietersrust, *Galpin 9094* (PRE).
—2527 (Rustenburg): Jack Scott Private Nature Reserve, *Wells 2324* (PRE).
—2528 (Pretoria): Fountain Grove, *Leendertz 122* (BOL, GRA, L).
—2529 (Witbank): Nooitgedacht, Loskopdam, *Theron 1223* (PRE).
—2531 (Komatipoort): Skipberg, Kruger National Park, *Van der Schijff 392* (PRE).
—2627 (Potchefstroom): near Magaliesberg, *Codd 2552* (PRE).
—2628 (Johannesburg): Suikerbosrand, 6 miles W. of Heidelberg, *Prosser 1309* (NBG, PRE).
NATAL—2929 (Underberg): Tabamhlope, *West 617* (PRE).
—2930 (Pietermaritzburg): Richmond, Byrne, *Galpin s.n.* (BOL).
—3030 (Port Shepstone): Totshe upper region, Port Shepstone, *Strey 7165* (PRE).
CAPE—2817 (Vioolsdrif): Vioolsdrif, *Wisura 1462* (NBG).
—2820 (Kakamas): near Riemvasmaak, western edge of Molopo Gorge, *Acocks 16383* (PRE).
—3029 (Kokstad): Mount Currie, *Tyson 1424* (G, GRA).
—3126 (Queenstown): Bowkers Park, Queenstown, *Galpin 2568* (GRA, PRE).
—3127 (Lady Frere): Cala, *Pegler 107* (GRA).
—3128 (Umtata): Ingungo, *Schlechter 6314* (GRA, P, Z).
—3226 (Fort Beaufort): top of Katberg Pass, *Dyer 2309* (GRA, PRE).
—3227 (Stutterheim): Thomas River, *Compton 19281* (NBG).
—3228 (Butterworth): Kentani, *Pegler 454* (BOL, PRE).
—3324 (Steytlerville): Armansvriend, *Noel 1548* (GRA).
—3327 (Peddie): Kaffir Drift, *Lloyd s.n.* sub PRE *32065* (PRE).

NOMINA DUBIA

Drimia dregeana Kunth, Enum. Pl. **4:** 340 (1843). Type: Cape, *Drège 1616c,* not traced and description inadequate. A specimen of *Scilla nervosa (Drège 4506a)* in S has been identified as *D. dregeana,* but without proof that it had been compared with the type.

Drimia eckloniana Schult. & Schult., Syst. Veg. **7:** 1710 (1830). Type: "in arenosis Prom. b. Spei", *Ecklon s.n.,* not traced and description inadequate.

Drimia pauciflora Bak. in Engl. Bot. Jahrb. **15,** Beibl. 35: 6–7 (1892). Type: "C.B.Spei (Ecklon et Zeyher, Asphod.n. 102)", not traced and description inadequate.

Drimia viridiflora Kunze in Linnaea **20:** 10 (1847). Type: Cape, *Gueinzius s.n.,* not located and description inadequate.

Ornithogalum calcaratum Bak. in Gdnrs' Chron. 1874, **1:** 723 (1874). Type: "eastern district of the Cape Colony", *MacOwan s.n.*, not located and description inadequate. Probably a species of *Drimia.*

Ornithogalum ciliatum L.f., Suppl. 199 (1781). Type: Cape, *Thunberg s.n.* (UPS–*8281*!). Probably a good species of *Drimia* but material at present insufficient. Leaves leathery, obovate, with ciliate margins; cf. notes on *D. marginata* (p. 295).

Urginea ciliata (L.f.) Bak. in J. Linn. Soc., Bot. **13:** 218 (1873).

Ornithogalum haworthioides Bak. in J. Bot., Lond. **1878:** 322 (1878). Type: "Cape Colony on hills near Graaff-Reinet", *Bolus 814*, not located and description inadequate. *Drimia bolusii* Bak. in Fl. Cap. **6:** 443 (1897), nom. nov. for *Ornithogalum haworthioides.*

Urginea berylloides Bak. in Bull. Herb. Boissier, sér. 2, **1:** 785–786 (1901). Type: Natal, Umgeni River, *Rehmann 8553*, not located and description inadequate.

Urginea muirii N.E. Br. in Gdnrs' Chron., ser. 3, **93:** 334 (1933). Type: Riversdale, *Muir 4846* (K, holo.!). This is a species of *Drimia,* but material insufficient for identification or description.

Urginea rigidifolia Bak. in J. Bot., Lond. **1878:** 323 (1878). Type: near Graaff Reinet, *Bolus 783* (K, holo.!). Resembles *D. anomala* but leaves 1–1,25 mm diameter and lacking abscission discs, pedicels 12–15 mm long. May be closer to *Rhadamanthus.*

NOMINA EXCLUSA

Anthericum filifolium Thunb., Prodr. **62** (1794). Type: ?"ex Hantam", *Thunberg s.n.* (UPS-*8372!*). *Ornithogalum* sp. *Anthericum nematodes* Schult. & Schult., Syst. Veg. **7:** 472 (1829), nom. nov. for *A. filifolium* Thunb.

Urginea nematodes (Schult. & Schult.) Bak. in J. Linn. Soc., Bot. **13:** 218 (1873).

Ornithogalum thunbergii Kunth, Enum. Pl. **4:** 369 (1843), nom. nov. for *Anthericum filifolium* Thunb.

Drimia angustifolia Kunth, Enum. Pl. **4:** 340 (1843). Type: Struisfontein, near Steelkloof, *Drège 8618b* (P, lecto.!). *Ledebouria undulata.*

Drimia chlorantha Bak. in Fl. Cap. **6:** 443 (1897). Type: near Sheba Battery, Avoca, *Galpin 1191* (K!, NH!, PRE!). *Albuca* sp.

Drimia ludwigii Miquel in Bull. Scien. Phys. Neerl. **1839:** 39–40 (1839). Type: specimen from Ludwig (inflorescence only) with full MS description by Miquel (U!). *Ledebouria undulata.*

Hyacinthus flexuosus Thunb., Prodr. Fl. Cap.: 64 (1794). Type: Cape, *Thunberg s.n.* (UPS). *Ornithogalum* sp.

Urginea acinacifolia Schinz in Beiträge zur Kenntn. Fl. S.W.A. in Verh. Brandenb. **31:** 220 (1890). Type: Oshando in S.E. Ondonga, *Schinz 24* (Z, lecto.!, K!). *Albuca angolensis* Welw.

Urginea dimorphantha Bak. in Bull. Herb. Boissier, sér. 2, **3:** 663 (1903). *Ornithogalum* sp.

Urginea lorata Bak. in Bull. Herb. Boissier, sér. 2, **3:** 664 (1903). Type: *Rautanen 771* (Z!). *Dipcadi* sp.

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This paper will be the last in a series based on a Ph.D. thesis submitted to Rhodes University in 1973.

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BOOK REVIEW

THE WEST AFRICAN HERBARIA OF ISERT AND THONNING. A TAXONOMIC REVISION AND AN INDEX TO THE IDC MICROFICHE, by F. N. Hepper, with pp. 227, 7 plates, 1 fig., 2 maps, 240 × 150 mm. Bentham-Moxon Trust, Royal Botanic Gardens, Kew, 1976. £6.50.

Two Danes, Isert and Thonning, made important plant collections in West Africa between 1783 and 1803; 610 species are represented and 474 names are typified by these specimens, which are mostly housed in the Botanical Museum, Copenhagen. Mr Hepper, during the course of his work on the Flora of West Tropical Africa, has checked the identity of all the specimens, sought duplicates in 10 other major herbaria, and revised the whole collection taxonomically and nomenclaturally. The main part of the book is a systematic list with the species arranged alphabetically by family and genus under their current names. Synonyms, vernacular names, translations of field notes, economic notes and localities are given. A supplementary list of references, a list of vernacular names and their botanical equivalents, a gazetteer of Isert's and Thonning's place names with their modern equivalents, and two maps (detailing the collecting areas of Isert and Thonning) are printed on coloured paper and inserted after the systematic list. Finally, there is a list of genera described as new from the Isert and Thonning collections and their present status, a list of Thonning's herbarium (and MSS) numbers with present and former determinations, and lists of the location of specimens in the various herbaria, with indexes to microfiches.

The introduction includes biographical notes on Isert and Thonning as well as von Rohr, Haasland Smith and Mortensen who also collected in West Africa about the same time as the two main collectors. Ole Haasland Smith is much less well known than *Hoslundia*, the genus named after him; it belongs to Labiatae and is remarkable for the fleshy orange calyx that surrounds the ripe nutlets.

This book will be an invaluable aid to workers on the African flora: not only are the determinations of these important early collections clarified, but there is a wealth of ancillary information. In particular it is interesting to read these early records of introduced plants, the weeds *Argemone mexicana* and *Chenopodium murale* for instance, while ginger (*Zingiber officinale*) and tumeric (*Curcuma domestica*), both Asiatic in origin, were being cultivated.

O. M. HILLIARD

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INSTRUCTIONS TO CONTRIBUTORS
TO THE
JOURNAL OF SOUTH AFRICAN BOTANY

This Journal provides a medium for the publication of the results of botanical research primarily on the flora of Southern Africa, whether systematic, morphological, ecological or otherwise and whether carried out in South Africa or elsewhere. Papers on botanical subjects of special interest and application in South Africa may be included.

Contributions must be original and should not be translations of previously published papers.

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Authors must use the international (SI) metric system for all measurements, e.g. linear units are to be expressed in metres and millimetres. The use of centimetres is to be avoided. (Metrication pamphlets are obtainable from the South African Bureau of Standards, Private Bag X191, Pretoria, 0001).

When a quotation is incorporated into the text, as in the instance of a locality citation in a taxonomic paper, the original units must be retained as they are of historical and archival importance.

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Authors must adhere to the International Rules of Botanical Nomenclature. **Abbreviations** and **herbaria** must be cited in accordance with the most recent edition of Index Herbariorum,

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> **Bequaertiodendron magalismontanum** (Sond.) Heine & J. H. Hemsley in Kew Bull. **1960:** 307 (1960).
> *Chrysophyllum magalismontanum* Sond. in Linnaea **23:** 72 (1850): Type: Magaliesberg, *Zeyher 1849* (S, holo; BOL!, SAM!).
> *Zeyherella magalismontana* (Sond.) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105:** 37 (1958).
> *Pouteria magalismontana* (Sond.) A. Meeuse in Bothalia **7:** 335 (1960).
> *Chrysophyllum argyrophyllum* Hiern, Cat. Afr. Pl. Welw. **3:** 641 (1898). Syntypes: Angola, *Welwitsch 4827, 4828, 4829* (BM!).
> *Boivinella argyrophylla* (Hiern) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105:** 37 (1958).
> *Chrysophyllum wilmsii* Engl., Mon. Sapot. Afr.: 47 t. 16 (1904). Type: Transvaal, *Wilms 1812* (B†, holo.; K!).
> *Boivinella wilmsii* (Engl.) Aubrév. & Pellegr. in Bull. Soc. bot. Fr. **105:** 37 (1958).

CITATION OF SPECIMENS

In the interests of uniformity contributors are requested to follow the recommendations of Leistner and Morris (*Ann. Cape prov. Mus.* **12:** 1976) by citing specimens according to the one degree grid system. Distribution data are given separately for each province and are arranged in the following sequences: South West Africa, Botswana, Transvaal, Orange Free State, Swaziland, Natal, Lesotho, Cape. Within each province degree squares are listed in numerical sequence, i.e., from west to east and from north to south. Whenever possible locality records should be given to within a quarter degree square. The collectors' names and numbers are underlined *(printed in italics)* to avoid confusion with the numbers of the degree squares, e.g.: NATAL-2829 (Harrismith): Cathedral Peak Forest Station (-CC), *Killick B127* (PRE); . . . CAPE-3418 (Simonstown): Hottentots Holland mountains, Somerset Sneeukop (-BB), Nov., *Stokoe s.n.* sub. SAM *56390* (SAM)

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> Davis, P. H. and Heywood, V. H., 1963. *Principles of Angiosperm Taxonomy*. Edinburgh and London: Oliver and Boyd.
> Riley, H. P., 1960. Chromosome numbers in the genus *Haworthia. Jl S. Afr. Bot.* **26:** 139–148.